United States
Department of
Agriculture

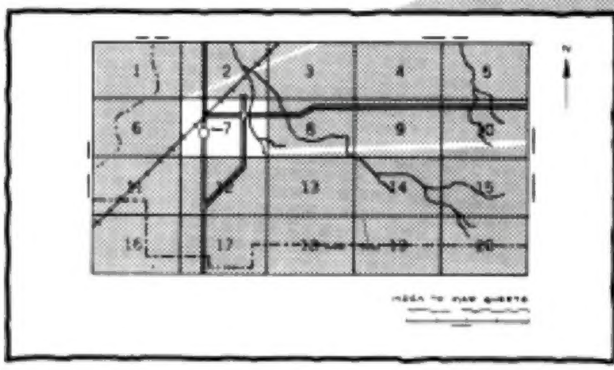
Soil
Conservation
Service

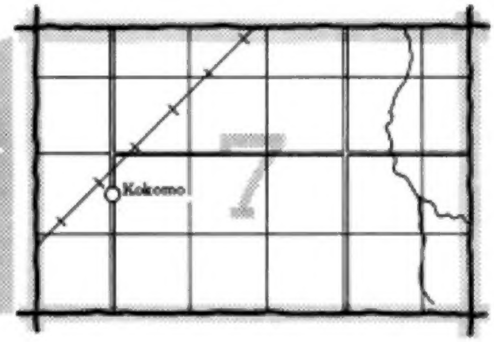
In Cooperation with
Kansas Agricultural
Experiment Station

Soil Survey of Marion County, Kansas

HOW TO USE

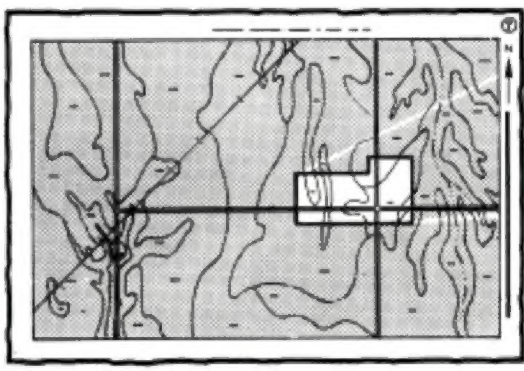
1. Locate your area of interest on the "Index to Map Sheets"

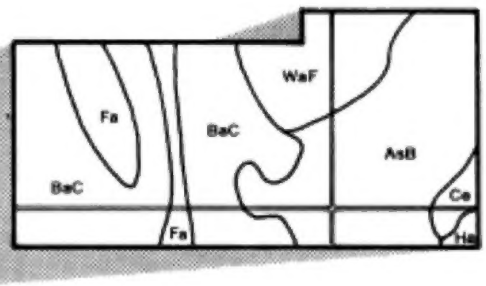




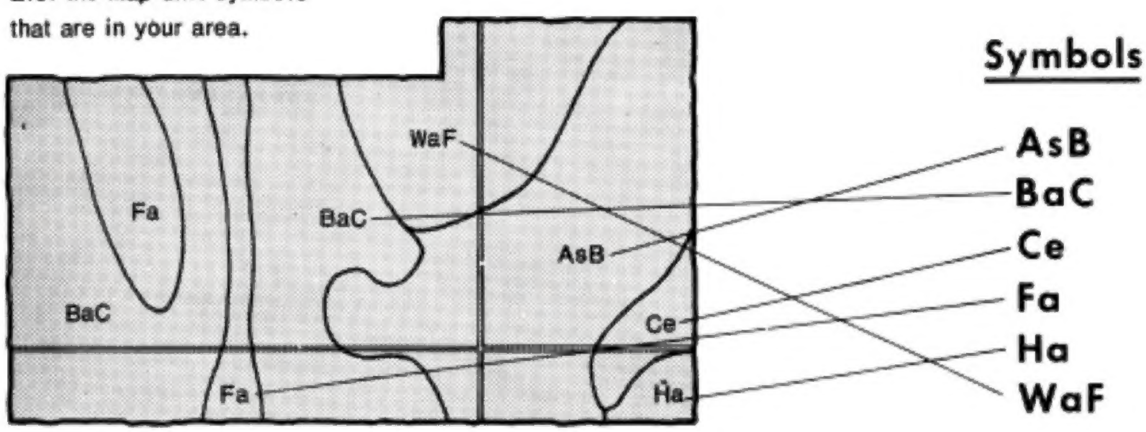
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



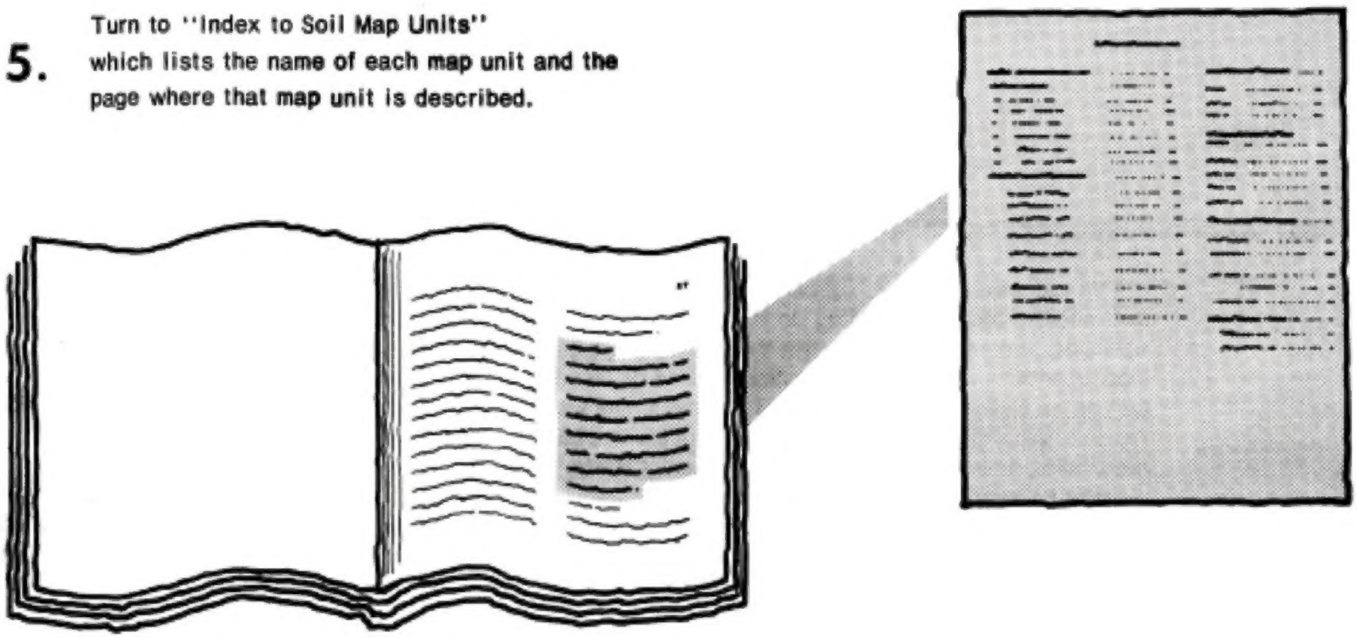


4. List the map unit symbols that are in your area.

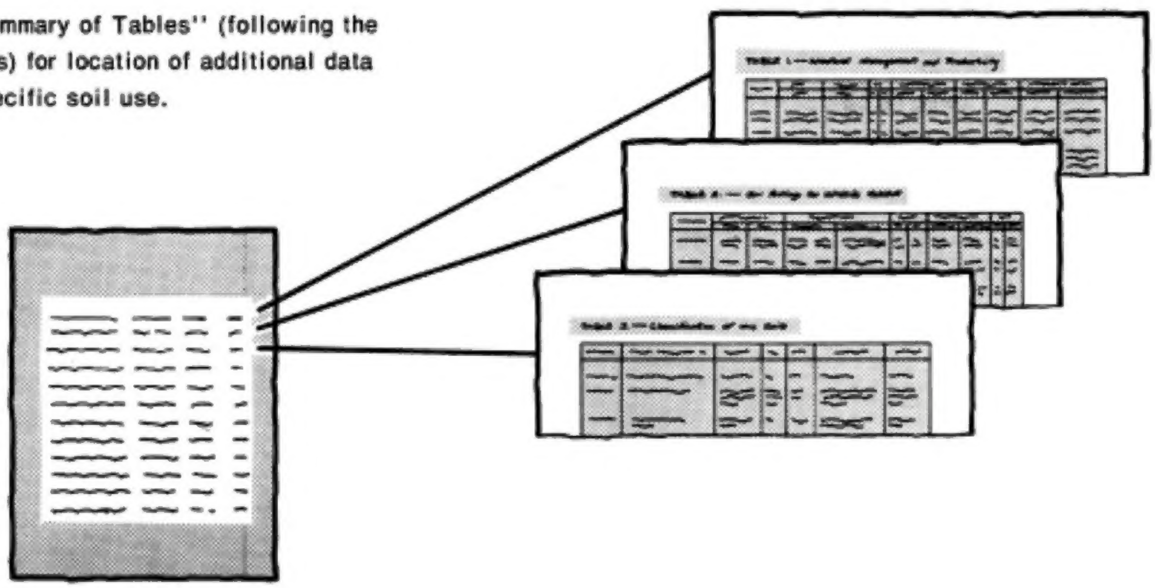


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Marion County Conservation District and County Commission. The Marion County Commission provided some of the personnel for the fieldwork. Major fieldwork for this soil survey was completed in 1977-1981. Soil names and descriptions were approved in 1981. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1981.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Grain sorghum and stubble mulch in an area of terraced and contour farmed Irwin silty clay loam, 1 to 3 percent slopes.

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Soil Series

Issued December 1983

Index to Map Units

Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Marion County, Kansas. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

John W. Tippie

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State Conservationist
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Soil Survey of
Marion County, Kansas

By Marcellus L. Horsch, Soil Conservation Service, and
Gene McFall, Marion County

United States Department of Agriculture, Soil Conservation Service
in cooperation with
Kansas Agricultural Experiment Station

Marion County is on the eastern edge of central Kansas (fig. 1). It has a total area of 613,760 acres, or 959 square miles. In 1980, the population of the county was 14,209, and that of the county seat, also named Marion, was 2,066. Marion County was organized in 1865.

Most of the county is in the Central Loess Plains Land Resource Area. The soils range from nearly level to moderately sloping, are generally deep or moderately deep, and have a silty clay loam surface layer and a clayey subsoil.

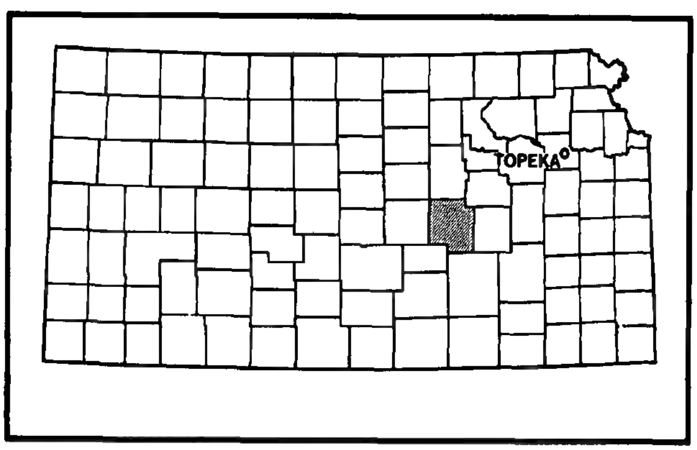

Figure 1.—Location of Marion County in Kansas.

The eastern one-fourth of the county is in the Bluestem Hills Land Resource Area, which has gently sloping to moderately steep topography dissected by deeply entrenched drainageways. The soils range from shallow to deep over limestone bedrock, and many areas of outcropping rock are near ridgetops.

The northwest part of the county is in the Central Kansas Sandstone Hills Land Resource Area and is characterized by hilly dissected plains. The soils are shallow to deep and have a loamy surface layer and subsoil underlain by sandstone and sandy shales.

Elevation ranges from 1,590 feet along the western border of the county to 1,220 feet east of Florence, where the Cottonwood River leaves the county.

The Cottonwood River and its tributaries drain about two-thirds of the county from northwest to southeast. An area along the north part of the county is drained to the north by Turkey Creek, Lyon Creek, and other intermittent streams. Areas along southern parts of the county are drained by Middle Emma Creek, East Emma Creek, Sand Creek, and Turkey Creek, which flow south.

The main enterprises in the county are farming and ranching. Wheat, grain sorghum, and alfalfa are the principal crops.

An older survey of Marion County, Kansas, was published in 1930 (*5*). The present survey updates the earlier survey and provides additional information and larger maps that show the soils in greater detail.

Descriptions, names, and delineations of soils in this soil survey do not fully agree with those on soil maps of adjoining counties. Differences are the result of better knowledge of soils, modifications in series concepts, intensity of mapping, or the extent of soils within the survey.

General Nature of the Survey Area

This section gives general information concerning the county. It discusses climate and natural resources.

Climate

Prepared by L. Dean Bark, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

Marion County has the continental climate typical of the interior of a large land mass in the middle latitudes. Such a climate is characterized by large daily and annual variations in temperature. Although winter lasts only from December through February it is cold because of frequent outbreaks of air from the polar regions. Warm summer temperatures last for about 6 months every year, and the transition seasons of spring and fall are relatively short. The warm temperatures provide a long growing season for crops in the county. Marion County is generally along the western edge of the flow of moisture-laden air from the Gulf of Mexico. Shifts in this current produce a rather wide range in the amount of precipitation that falls on the county. Precipitation is heaviest from May through September, with a large part of it coming from late evening or nighttime thunderstorms. In dry years, precipitation is marginal for agricultural production, and even in wet years, frequent prolonged periods without rain produce stress in growing crops.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Florence in the period 1951 to 1976. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 33.2 degrees F and the average daily minimum temperature is 21.6 degrees. The lowest temperature on record, which occurred at Marion on February 12, 1899, is -29 degrees. In summer the average temperature is 78.0 degrees, and the average daily maximum temperature is 90.7 degrees. The highest recorded temperature, which occurred at Florence on July 13 and 14, 1954, is 115 degrees.

The total annual precipitation is 32.85 inches. Of this, 23.77 inches, or 72 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 16.93 inches. The heaviest 1-day rainfall during the period of record was 9.46 inches at Hillsboro on July 11, 1963.

The average seasonal snowfall is 18.3 inches The greatest snow depth at any one time during the period of record was 54.8 inches. On an average of 17 days, at least 1 inch of snow is on the ground, but it is unusual for the snow cover to last over 7 days in succession.

The sun shines 75 percent of the time possible in summer and 61 percent in winter. The prevailing wind is from the south. Average windspeed is 12.5 miles per hour. It is highest in March and April.

Tornadoes and severe thunderstorms strike occasionally in Marion County. These storms are usually local in extent and of short duration. Hail falls during the warmer part of the year, but it, too, is infrequent and localized. Hail damages crops less in the survey area than in parts of the state further west.

Natural Resources

Soil is the most important natural resource in Marion County. The soil affects such marketable products as livestock and crops.

Oil and gas are important mineral resources in Marion County. Other mineral resources are sand, gravel, and limestone. Sand and gravel from pits along the South Cottonwood River are used in construction or road improvement. Large quantities of crushed aggregate from limestone quarries near Marion and Florence are used in road maintenance.

Ground water is generally of poor quality and low yield. Wells that yield 100 to 500 gallons per minute are in an area in the central part of the county; wells in the rest of the county yield from 10 to 100 gallons per minute. About 2,600 acres of cropland is irrigated. Water for several irrigation systems comes from wells. A few systems depend on water from streams, but the water supply from streams is limited, and water often is not available when needed. In places, the supply of water from wells is inadequate for domestic and livestock use. Rural Water Districts have been formed, and three of these are presently in use.

Sources of surface water are ponds, springs, lakes, and perennial streams.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management

of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another resulting in gradual changes in characteristics. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting

(dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed, and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soils on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation to precisely define and locate the soil is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows broad areas called soil associations that have a distinctive pattern of soils, relief, and drainage. Each soil association on the general soil map is a unique natural landscape. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one soil association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

1. Irwin-Ladysmith Association

Deep, nearly level to moderately sloping, moderately well drained and somewhat poorly drained soils that have a clayey subsoil; on uplands

This association is on broad, smooth ridgetops that are dissected by small drainageways. Areas along drainageways and streams are gently sloping or moderately sloping, and the ridgetops are nearly level. Slope ranges from 0 to 6 percent.

This association makes up about 17 percent of the county. It is about 65 percent Irwin soils and 20 percent Ladysmith soils. The remaining 15 percent is minor soils (fig. 2).

The moderately well drained Irwin soils formed in old alluvium on side slopes and ridgetops. Typically, the surface layer is dark grayish brown silty clay loam about 7 inches thick. The subsurface layer is dark grayish brown, firm silty clay loam about 6 inches thick. The subsoil is very firm silty clay about 27 inches thick. The upper part is dark brown, and the lower part is brown and contains some fine lime concretions. The substratum to a depth of about 60 inches is brown, mottled silty clay.

The somewhat poorly drained Ladysmith soils formed in old alluvium on ridgetops. Typically, the surface layer is dark gray silty clay loam about 9 inches thick. The subsoil is about 43 inches thick. The upper part is dark gray, very firm silty clay. The middle part is gray, mottled, very firm silty clay. The lower part is grayish brown, mottled, very firm silty clay that contains a few fine lime concretions. The substratum to a depth of about 60 inches is light brownish gray, mottled, silty clay that contains a few fine lime concretions.

The minor soils in this association are Clime, Goessel, and Rosehill soils. The moderately deep, calcareous Clime soils are on lower side slopes and on the sides of upland drainageways. The clayey Goessel soils are in slight depressions. The moderately deep Rosehill soils are on side slopes.

This association is used mainly for cultivated crops. Some small areas are used for hay or pasture. Wheat and grain sorghum are the main crops. Controlling erosion and maintaining soil tilth and fertility are concerns in managing the cultivated areas of these soils.

2. Labette-Tully-Sogn Association

Deep to shallow, nearly level to strongly sloping, well drained and somewhat excessively drained soils that have a clayey or silty subsoil; on uplands

This association is on ridgetops and side slopes. Small streams and drainageways dissect these areas to form narrow valleys. Rock outcrops are commonly on the breaks of the ridgetops and on upper side slopes. Slope ranges from 0 to 15 percent. However, in a few areas along drainageways, the side slopes are somewhat steeper.

This association makes up about 19 percent of the county. It is about 34 percent Labette soils, 24 percent Tully soils, and 20 percent Sogn soils. The remaining 22 percent is minor soils (fig. 3).

The moderately deep, well drained Labette soils formed in residuum of limestone on ridgetops and upper side slopes. Typically, the surface layer is dark grayish brown silty clay loam about 8 inches thick. The subsurface layer is dark grayish brown, firm silty clay loam about 7 inches thick. The subsoil is about 16 inches thick. The upper part is dark brown, very firm silty clay. The lower part is brown, very firm silty clay that contains a few fine lime concretions. The substratum is brown silty clay that contains a few small fragments of limestone. Hard limestone is at a depth of about 36 inches.

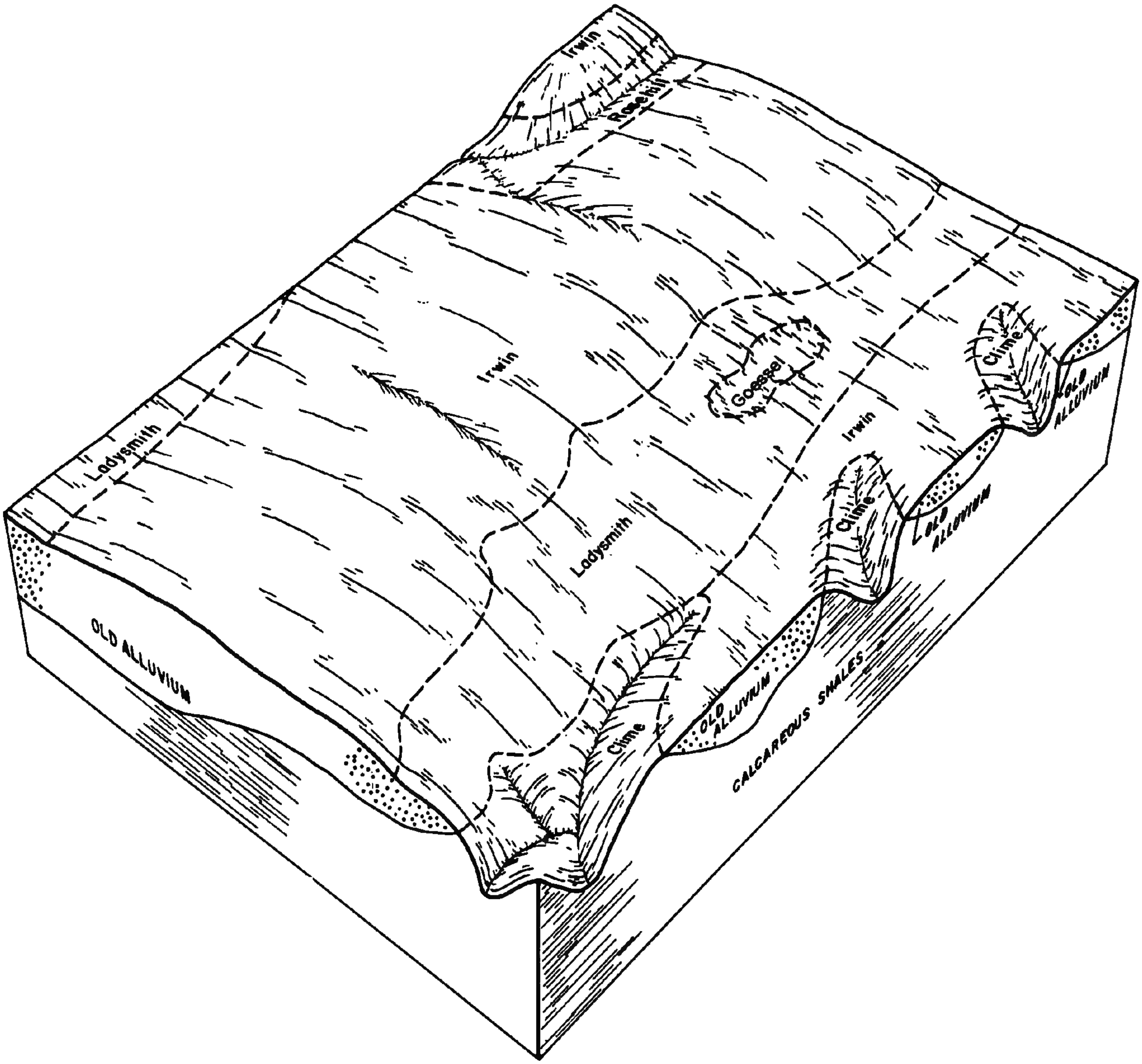

Figure 2.—Typical pattern of soils and underlying material in the Irwin-Ladysmith association.

The deep, well drained Tully soils formed in colluvium on foot slopes. Typically, the surface soil is very dark gray silty clay loam about 17 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown, very firm silty clay. The middle part is brown, very firm silty clay. The lower part is dark brown, firm silty clay that contains a few fine lime concretions. The substratum to a depth of about 60 inches is reddish brown silty clay that contains a few fine lime concretions.

The shallow, somewhat excessively drained Sogn soils formed in residuum from limestone on ridgetops and upper side slopes. Typically, the surface layer is dark

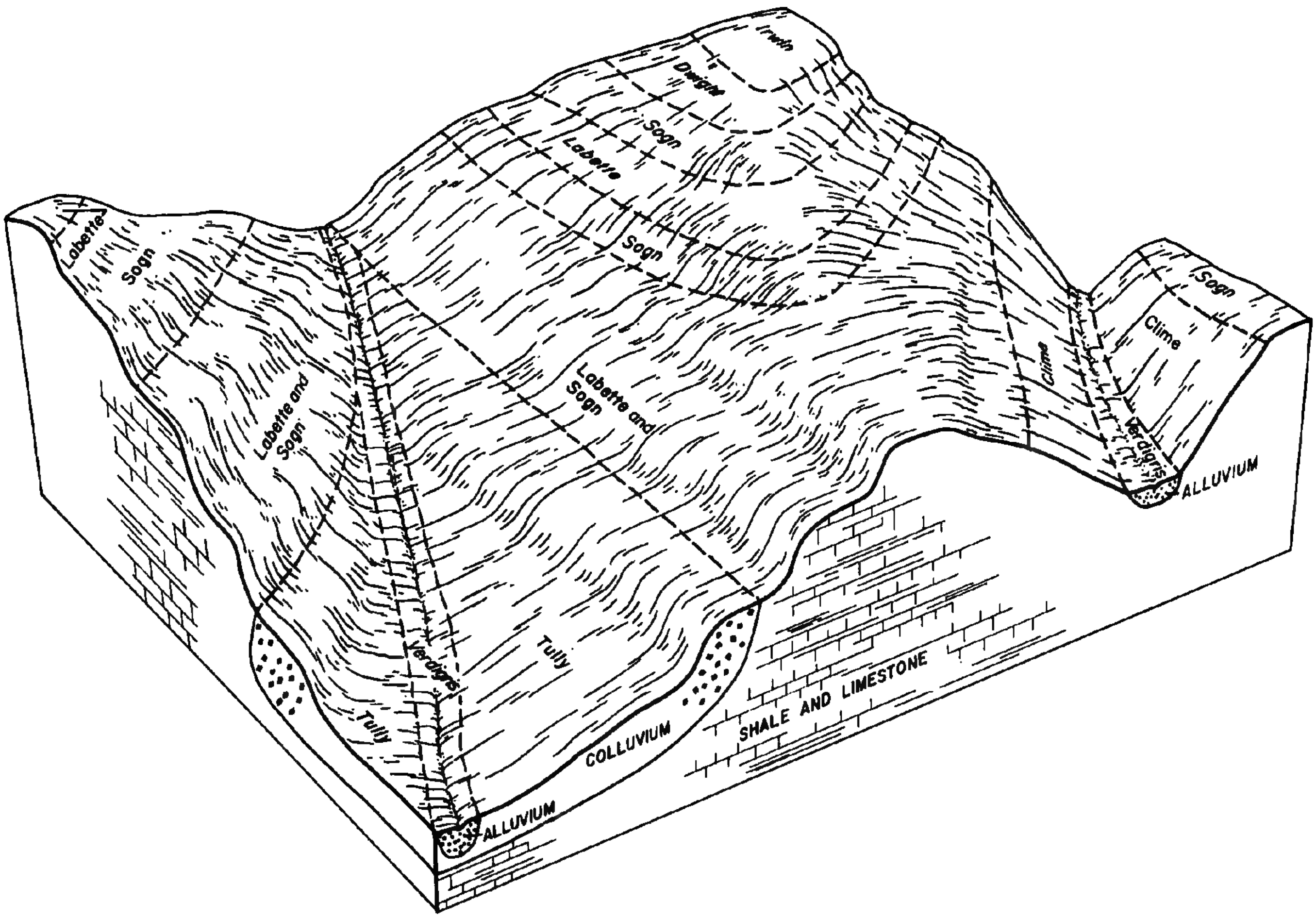

Figure 3.—Typical pattern of soils and underlying materials in the Labette-Tully-Sogn association.

gray silty clay loam about 8 inches thick. Limestone underlies the surface layer.

The minor soils in this association are Clime, Dwight, Florence, Irwin, and Verdigris soils. The limy Clime soils are on the steeper side slopes. The deep, moderately well drained Dwight and Irwin soils are on ridgetops. The Florence soils have a cherty subsoil and are on ridgetops and side slopes. The deep, moderately well drained Verdigris soils are on narrow flood plains.

About 80 percent of the acreage of this association is used for rangeland, and about 20 percent is used for cropland. Maintaining the growth and vigor of desirable grasses is the main concern in managing rangeland. Controlling erosion and conserving moisture are concerns in managing cropland.

3. Verdigris-Chase-Reading Association

Deep, nearly level, moderately well drained, somewhat poorly drained, and well drained soils that have a silty or clayey subsoil; on flood plains and stream terraces

This association is on bottom lands of the major streams in the county. The soils are subject to flooding. Slope ranges from 0 to 2 percent.

This association makes up about 3 percent of the county. It is about 40 percent Verdigris soils, 30 percent Chase soils, and 20 percent Reading soils. The remaining 10 percent is minor soils.

The moderately well drained Verdigris soils formed in silty alluvium on flood plains. Typically, the surface layer is dark grayish brown silt loam about 9 inches thick. The next layer is dark grayish brown, friable silt loam about 31 inches thick. The substratum to a depth of about 60 inches is grayish brown silt loam.

The somewhat poorly drained Chase soils formed in clayey alluvium on low stream terraces. Typically, the surface soil is dark gray silty clay loam about 12 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark gray, firm silty clay loam. The middle part is dark gray, very firm silty clay. The lower part is grayish brown, mottled, very firm silty clay.

The well drained Reading soils formed in silty alluvium on stream terraces. Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown, friable silty clay loam about 6 inches thick. The subsoil is brown, firm silty clay loam about 30 inches thick. The substratum to a depth of about 60 inches is brown silty clay loam.

The minor soils in this association are Osage, Tully, and Wells soils. The poorly drained Osage soils are in slight depressions on flood plains. The deep, well drained Tully and Wells soils are on foot slopes of adjacent uplands.

This association is used mainly for cultivated crops. Some small areas are used for hay and pasture. Wheat, grain sorghum, soybeans, and alfalfa are the main crops. The main concerns of management are controlling flooding and maintaining good soil tilth and fertility.

4. Wells-Verdigris Association

Deep, nearly level to moderately sloping, well drained and moderately well drained soils that have a loamy or silty subsoil; on uplands and flood plains

This association is on narrow upland ridges and short side slopes adjacent to flood plains along major streams in the county. Slope ranges from 0 to 7 percent.

This association makes up about 14 percent of the county. It is about 47 percent Wells soils, 33 percent Verdigris soils, and 20 percent minor soils.

The well drained Wells soils formed in old alluvium or in residuum from noncalcareous sandstone on ridgetops and side slopes. Typically, the surface layer is dark brown loam about 9 inches thick. The subsoil is about 27 inches thick. The upper part is dark reddish gray, friable loam. The lower part is reddish brown, firm sandy clay loam. The substratum to a depth of about 60 inches is reddish brown sandy loam.

The moderately well drained Verdigris soils formed in silty alluvium on flood plains. Typically, the surface soil is dark grayish brown silt loam about 9 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 13 inches thick. The next layer is dark grayish brown, friable silt loam about 18 inches thick. The substratum to a depth of about 60 inches is grayish brown silt loam.

The minor soils in this association are Clime, Irwin, and Reading soils. The moderately deep, limy Clime soils are on upper side slopes; the moderately well drained Irwin soils are on the ridgetops; and the well drained Reading soils are on stream terraces.

This association is used mainly for cultivated crops. Some small areas are used for hay or pasture. Wheat, grain sorghum, and alfalfa are the main cultivated crops. Controlling erosion and flooding and maintaining tilth and fertility are concerns in managing cropland.

5. Ladysmith-Goessel Association

Deep, nearly level, somewhat poorly drained and moderately well drained soils that have a clayey subsoil; on uplands

This association is on broad uplands that are dissected by shallow, intermittent streams. In some places, the nearly level terrain is modified by mounds of loamy material. Slope ranges from 0 to 2 percent.

This association makes up about 4 percent of the county. It is about 40 percent Ladysmith soils, 30 percent Goessel soils, and 30 percent minor soils (fig. 4).

The somewhat poorly drained Ladysmith soils formed in old alluvial sediments. Typically, the surface layer is dark gray silty clay loam about 9 inches thick. The subsoil is about 43 inches thick. The upper part is dark gray, very firm silty clay. The middle part is gray, mottled, very firm silty clay. The lower part is grayish brown, mottled, very firm silty clay that contains a few fine lime concretions. The substratum to a depth of about 60 inches is light brownish gray, mottled, silty clay that contains a few fine lime concretions.

The moderately well drained Goessel soils formed in clayey old alluvium. Typically, the surface layer is very dark gray silty clay about 6 inches thick. The subsurface layer is very dark gray, very firm silty clay about 7 inches thick. The next layer is about 29 inches thick. The upper part is dark gray, firm silty clay. The middle part is gray, mottled, extremely firm clay. The lower part is grayish brown, mottled, very firm clay. The substratum to a depth of about 60 inches is light brownish gray, mottled clay that contains a few lime concretions.

The minor soils in this association are Clime, Irwin, and Wells soils. The moderately deep Clime soils and moderately well drained Irwin soils are on sides of upland drainageways. The loamy Wells soils are on mounds or ridges.

This association is used mainly for cultivated crops. Wheat and grain sorghum are the main crops. Maintaining soil tilth and conserving moisture are the main concerns of management.

6. Lancaster-Hedville Association

Moderately deep and shallow, gently sloping to strongly sloping, well drained and somewhat excessively drained soils that have a loamy subsoil; on uplands

This association is on ridgetops and side slopes that have sandstone outcrops in some areas. The ridgetops are narrow in the steeper areas and broaden out in the gently sloping areas. The side slopes are irregular in length in most areas. Most areas of this association are drained by well entrenched intermittent streams and creeks. Slope ranges from 1 to 20 percent.

This association makes up about 3 percent of the county. It is about 57 percent Lancaster soils, 14 percent Hedville soils, and 29 percent minor soils (fig. 5).

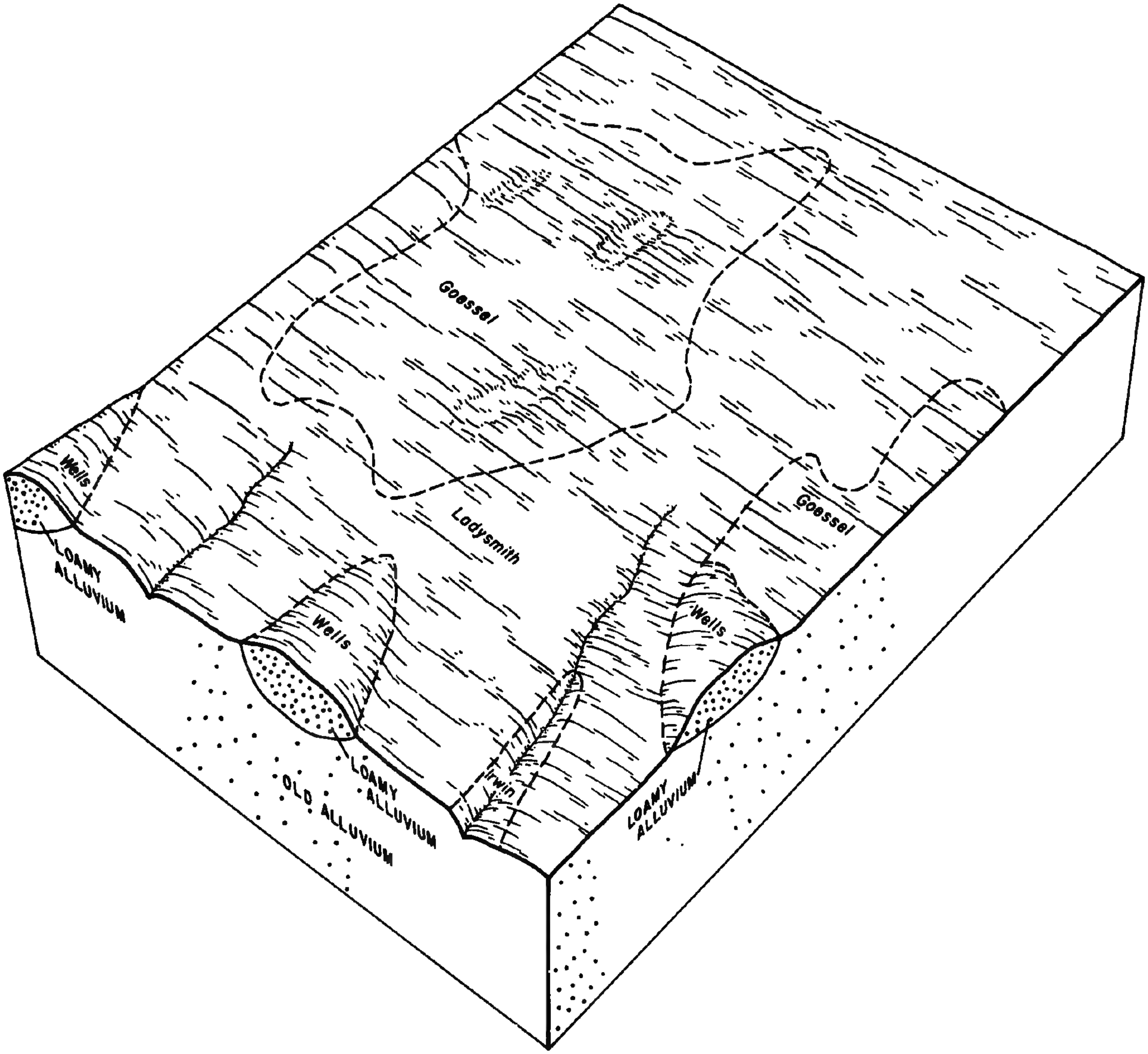

Figure 4.—Typical pattern of soils and underlying materials in the Ladysmith-Goessel association.

The well drained Lancaster soils formed in residuum of noncalcareous sandstone and sandy shales on ridgetops and side slopes. Typically, the surface layer is brown loam about 7 inches thick. The subsoil is about 28 inches thick. The upper part is brown, friable sandy clay loam. The middle part is reddish brown, firm clay loam. The lower part is reddish brown, friable sandy clay loam. Sandstone is at a depth of about 35 inches.

The somewhat excessively drained Hedville soils formed in residuum from noncalcareous sandstone on narrow ridgetops and upper side slopes. Typically, the surface layer is dark grayish brown stony loam about 10 inches thick. The subsurface layer is brown loam about 7 inches thick. Sandstone is at a depth of about 17 inches.

The minor soils in this association are Cass, Edalgo, Irwin, and Wells soils. The moderately sandy Cass soils are on narrow flood plains, and the moderately deep Edalgo soils are on side slopes. The deep Irwin soils are on ridgetops intermingled with Lancaster soils; and the

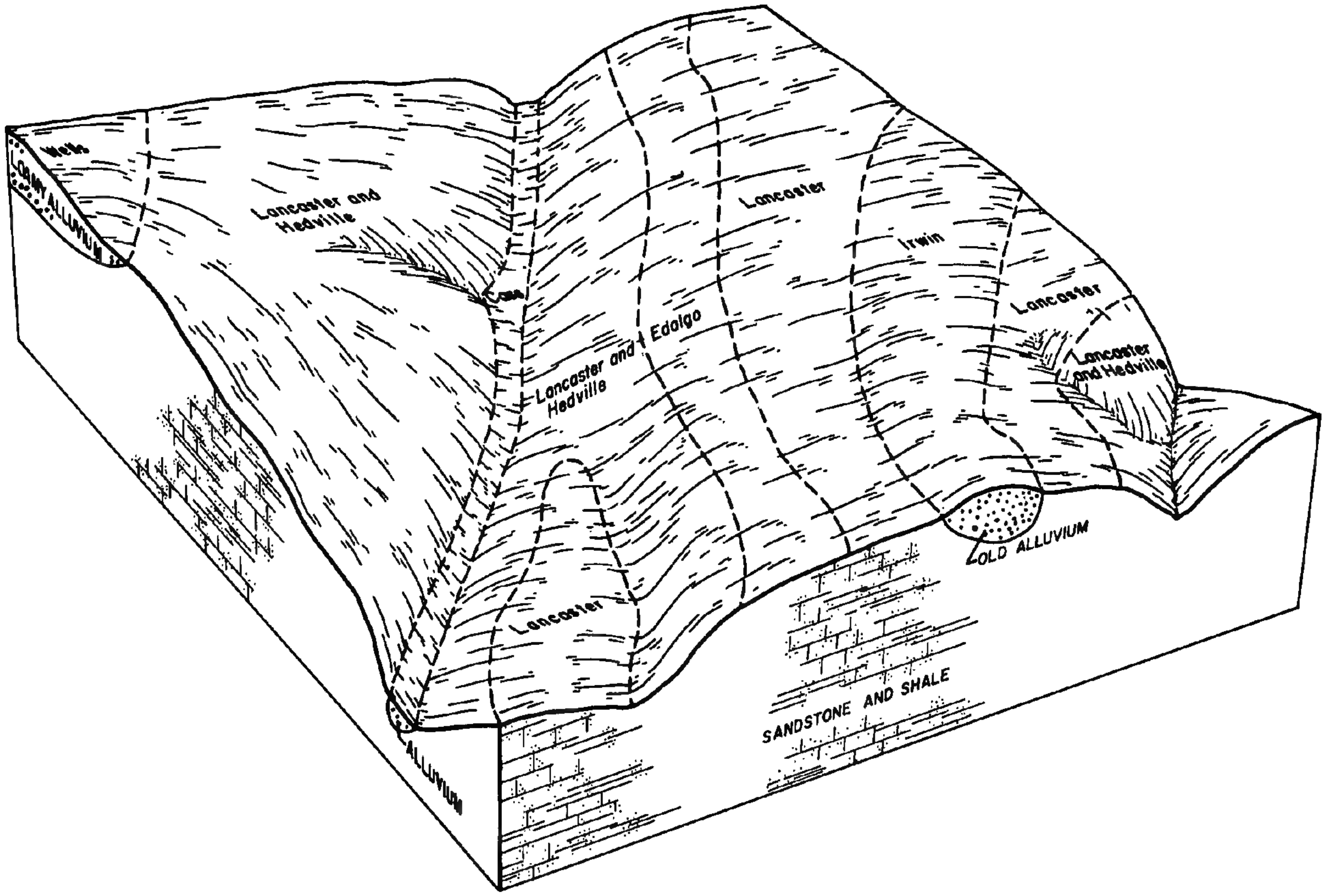

Figure 5.—Typical pattern of soils and underlying materials in the Lancaster-Hedville association.

deep, loamy Wells soils are on ridgetops and lower side slopes.

About half of the acreage of this association is used for rangeland, and the rest is used for cultivated crops. Wheat, grain sorghum, and alfalfa are the main crops. Controlling erosion and conserving moisture are concerns of management in cultivated areas. Maintaining the growth and vigor of desirable grasses is the main concern in managing rangeland.

7. Irwin-Clime Association

Deep and moderately deep, gently sloping to moderately steep, moderately well drained and well drained soils that have a clayey or silty subsoil; on uplands

This association is on ridgetops and side slopes on uplands that are dissected by numerous intermittent streams and creeks. The side slopes generally are long and smooth. Limy shale rock fragments are scattered on the surface of side slopes. Slope ranges from 1 to 20 percent.

This association makes up about 38 percent of the county. It is about 45 percent Irwin soils, 38 percent Clime soils, and 17 percent minor soils (fig. 6).

The deep, moderately well drained Irwin soils formed in old alluvium on upper side slopes and ridgetops. Typically, the surface layer is dark grayish brown silty clay loam about 7 inches thick. The subsurface layer is dark grayish brown, firm silty clay loam about 6 inches thick. The subsoil is very firm silty clay about 27 inches thick. The upper part is dark brown, and the lower part is brown and contains some fine lime concretions. The substratum to a depth of about 60 inches is brown, mottled silty clay.

The moderately deep, well drained Clime soils formed in residuum of calcareous, clayey shale on side slopes. Typically, the surface layer is dark gray, calcareous silty clay loam about 10 inches thick. The subsoil is pale brown, firm, calcareous silty clay loam about 13 inches thick. The substratum is pale yellow, calcareous silty clay. Calcareous shale is at a depth of about 30 inches.

The minor soils in this association are Kipson, Ladysmith, Lancaster, Rosehill, and Verdigris soils. The shallow, moderately steep Kipson soils are on side slopes; the somewhat poorly drained nearly level

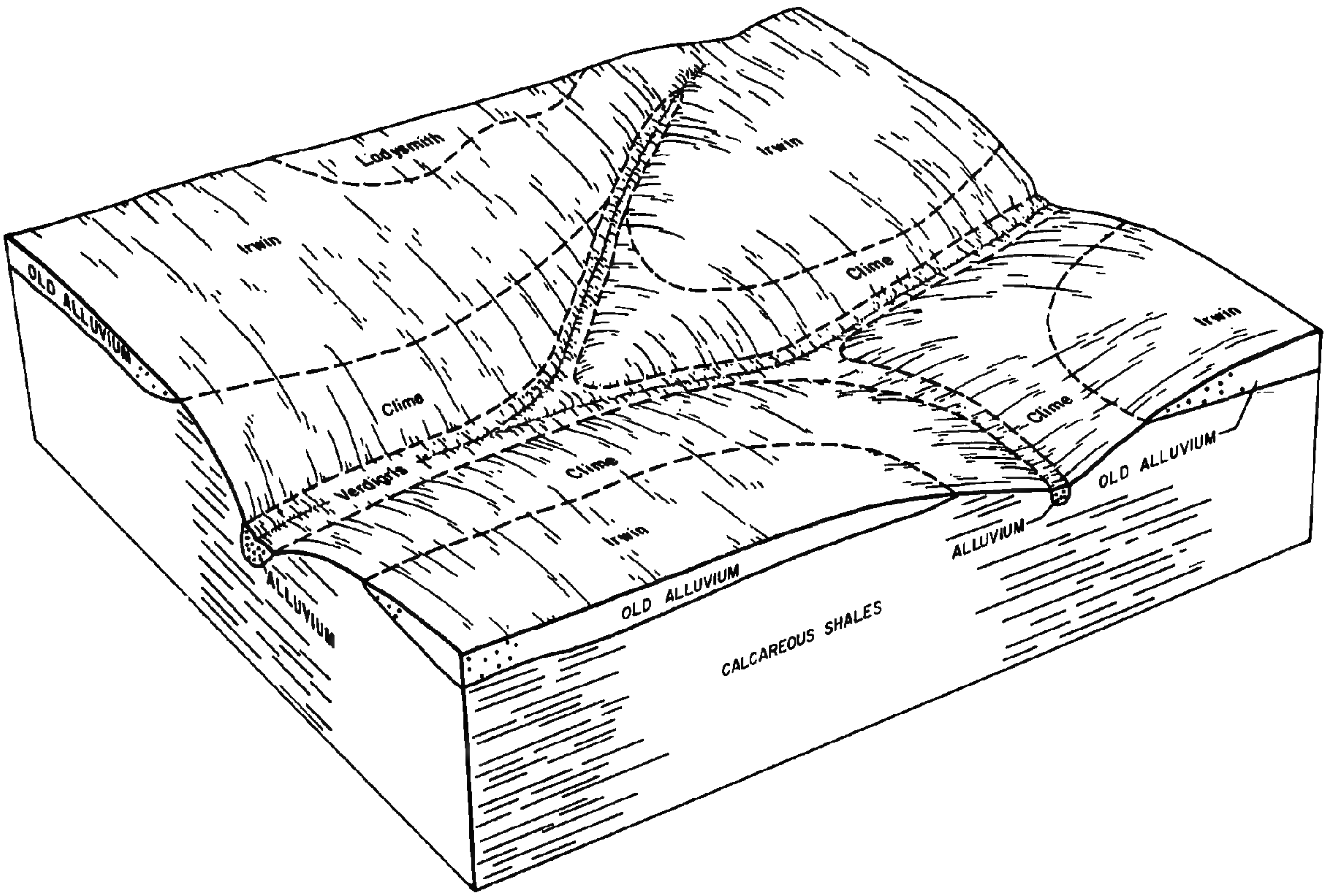

Figure 6.—Typical pattern of soils and underlying material in the Irwin-Clime association.

Ladysmith soils are on ridgetops; the moderately deep Lancaster soils are near drainageways; the clayey Rosehill soils are on side slopes; and the deep Verdigris soils are on flood plains.

The gently sloping and moderately sloping soils of this association are used mainly for cultivated crops. The steeper soils are used for native range. Wheat, grain sorghum, and alfalfa are the main cultivated crops. Controlling erosion and maintaining tilth and fertility are concerns in managing cultivated areas of these soils. Good range management is needed to maintain the desirable grasses.

8. Goessel-Rosehill Association

Deep and moderately deep, nearly level and gently sloping, moderately well drained soils that have a clayey subsoil; on uplands

This association is on broad ridgetops and smooth side slopes that are dissected by shallow, intermittent streams. Slope ranges from 0 to 3 percent.

This association makes up about 2 percent of the county. It is about 52 percent Goessel soils, 35 percent Rosehill soils, and 13 percent minor soils.

The deep Goessel soils formed in clayey old alluvium on broad upland ridgetops. Typically, the surface layer is very dark gray silty clay about 6 inches thick. The subsurface layer is very dark gray silty clay about 7 inches thick. The next layer is about 29 inches thick. The upper part is dark gray, firm silty clay. The middle part is gray, mottled, extremely firm clay. The lower part is grayish brown, mottled, very firm clay. The substratum to a depth of about 60 inches is light brownish gray, mottled clay that contains a few lime concretions.

The moderately deep Rosehill soils formed in residuum of clayey shale on side slopes. Typically, the surface layer is very dark gray silty clay about 8 inches thick. The subsoil is about 20 inches thick. The upper part is dark grayish brown, extremely firm silty clay. The lower part is pale olive, mottled, extremely firm silty clay that contains a few fine lime concretions. Shale is at a depth of about 28 inches.

The minor soils in this association are Clime, Irwin, and Verdigris soils. The limy Clime soils are on lower side slopes near drainageways; the deep, silty Irwin soils are on side slopes; and the silty Verdigris soils are on flood plains of drainageways.

This association is used mainly for cultivated crops. Wheat and grain sorghum are the main crops. Controlling erosion, conserving moisture, and maintaining soil tilth are the main concerns of management.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Irwin silty clay loam, 1 to 3 percent slopes, is one of several phases in the Irwin series.

Some map units are made up of two or more major soils. These map units are called soil complexes.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Lancaster-Hedville complex, 3 to 20 percent slopes is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, quarries, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

Ca—Cass fine sandy loam. This deep, nearly level, well drained soil is on flood plains along streams. It is occasionally flooded for brief periods. Individual areas are long and narrow and range from 10 to 60 acres in size.

Typically, the surface soil is dark grayish brown fine sandy loam about 18 inches thick. The next layer is brown, friable fine sandy loam about 15 inches thick. The substratum to a depth of about 60 inches is brown fine sandy loam. In some places, the surface soil is loam or loamy fine sand, and the substratum is faintly mottled.

Included with this soil in mapping and making up about 10 percent of the map unit are small areas of Lancaster and Verdigris soils. Also included are areas of somewhat poorly drained soils that have textures similar to those of Cass soils. The moderately deep Lancaster soils are on side slopes adjacent to the flood plain. The silty Verdigris soils are in a position on the flood plain similar to that of the Cass soil.

Permeability in this Cass soil is moderately rapid, and available water capacity is high. Runoff is slow. Natural fertility is medium, and organic matter content is moderate. Tilth is good. The surface soil is slightly acid.

Most of the acreage of this soil is used for cultivated crops. This soil is well suited to grain sorghum, wheat, soybeans, and alfalfa. If it is used for cultivated crops, flood damage and soil blowing are hazards. Leaving crop residue on the surface and using minimum tillage help maintain good tilth, fertility, and organic matter content and help control soil blowing.

This soil is generally unsuited to building sites because of flooding. Flooding is difficult to overcome without major flood control measures.

The capability subclass of this soil is IIw, and the range site is Sandy Lowland.

Ch—Chase silty clay loam. This deep, nearly level, somewhat poorly drained soil is on low stream terraces. It is occasionally flooded for very brief periods. Slopes are plane to weakly concave. Individual areas are irregular in shape and range from 40 to 200 acres in size.

Typically, the surface soil is dark gray silty clay loam about 12 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is dark gray, firm silty clay loam; the middle part is dark gray, very firm silty clay; and the lower part is grayish brown, mottled, very firm silty clay. In some places, the surface soil is silty clay. In places, the subsoil is calcareous below a depth of 30 inches.

Included with this soil in mapping are small areas of the moderately well drained Verdigris soil near the stream channel. Verdigris soils make up 5 to 10 percent of the map unit.

Permeability in this Chase soil is slow, and available water capacity is high. Runoff is slow. Tilth is good. Natural fertility is high, and organic matter content is moderate. The surface layer is medium acid. The subsoil has high shrink-swell potential. The perched seasonal high water table is between depths of 2 and 4 feet during the spring.

Nearly all of the acreage of this soil is used for cultivated crops. This soil is well suited to wheat, grain sorghum, soybeans, and alfalfa. Wetness, however, may delay spring planting, and flood damage is a hazard. Installing surface drains or filling depressions helps improve surface drainage. Leaving crop residue on the surface and using minimum tillage help maintain good tilth, fertility, and organic matter content and increase the rate of moisture infiltration.

This soil is generally unsuited to building sites because of flooding. Flooding is difficult to overcome without major flood control measures.

The capability subclass of this soil is IIw, and the range site is Loamy Lowland.

Cm—Clime silty clay loam, 1 to 3 percent slopes. This moderately deep, gently sloping, well drained soil is on upland ridgetops and side slopes. Individual areas are irregular in shape and range from 20 to 200 acres in size.

Typically, the surface layer is very dark gray, calcareous silty clay loam about 10 inches thick. The subsoil is pale brown, firm, calcareous silty clay loam about 13 inches thick. The substratum is pale yellow, calcareous silty clay. Calcareous shale is at a depth of about 30 inches. In places, the depth to shale is less than 20 inches. In places, the surface layer and subsoil are noncalcareous. In areas where the upper part of the subsoil has been mixed with the surface soil by tillage, the surface layer is brown or pale brown.

Included with this soil in mapping and making up about 10 percent of the map unit are small areas of Irwin soils. The deep, noncalcareous Irwin soils have a more clayey subsoil than the Clime soil and are on upper side slopes and ridgetops.

Permeability in this Clime soil is slow, and runoff is medium. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. Tilth is good. The surface layer is moderately alkaline. The subsoil has moderate shrink-swell potential. Root development is restricted below a depth of about 30 inches.

Nearly all of the acreage of this soil is used for cultivated crops. This soil is moderately well suited to wheat, grain sorghum, soybeans, and alfalfa. Erosion is a hazard if cultivated crops are grown. The soil is droughty in the summer because the clayey subsoil releases water slowly. Use of minimum tillage, terraces, grassed waterways, contour farming, and crop residue management help to control runoff and erosion.

This soil is moderately well suited to local roads and streets and to dwellings. Low strength is a limitation for local roads and streets, and shrink-swell potential is a limitation for dwellings. Roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for low strength of the soil material. Coarse-grained base material can be used to reduce damage caused by shrinking and swelling of the soil. For dwellings, properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material reduce damage caused by low strength and by shrinking and swelling of the soil. Depth to bedrock is also a limitation for dwellings with basements, but the rock is generally soft and can be easily excavated.

This soil is generally unsuited to septic tank absorption fields because of slow permeability and depth to bedrock. It is poorly suited to sewage lagoons. The construction of sewage lagoons requires borrowing soil or ripping because of the moderate depth to bedrock. The bottom of the lagoon may need to be sealed to prevent excessive seepage into fractures in the bedrock. Deeper soils included in this map unit are better suited. If less sloping soils are selected, lagoon construction requires less leveling and banking.

The capability subclass of this soil is IIIe, and the range site is Limy Upland.

Cp—Clime silty clay loam, 3 to 7 percent slopes. This moderately deep, moderately sloping, well drained soil is on side slopes of the uplands. Individual areas of this soil are irregular in shape and range from 10 to 300 acres in size.

Typically, the surface layer is very dark gray, calcareous silty clay loam about 7 inches thick. The subsoil is pale brown, firm, calcareous silty clay loam about 13 inches thick. The substratum is pale yellow, very firm, calcareous silty clay. Calcareous shale is at a depth of about 27 inches. In places, the depth to shale is less than 20 inches. In areas where the upper part of the subsoil has been mixed with the surface soil by tillage, the surface layer is brown or pale brown. In a few places, the underlying shale is reddish brown.

Included with this soil in mapping are small areas of Irwin soils. The Irwin soils are more than 40 inches deep to shale and are on ridgetops and lower side slopes. Irwin soils make up about 10 percent of the map unit.

Permeability in this Clime soil is slow, and available water capacity is moderate. Runoff is rapid. Natural fertility is medium, and organic matter content is moderate. Tilth is good. The subsoil has moderate shrink-swell potential. The surface layer is moderately alkaline. Root development is restricted below a depth of about 27 inches.

This soil is poorly suited to cultivated crops. However, about 75 percent of the acreage of this soil is used for cultivated crops, and the rest is used for rangeland. Wheat, grain sorghum, and alfalfa are the main crops. Erosion is a hazard if cultivated crops are grown. The soil is droughty in the summer because the clayey subsoil releases water slowly. Use of minimum tillage, grassed waterways, terraces, contour farming, and crop residue management help reduce erosion and maintain organic matter content and good tilth. Leaving crop residue on the surface reduces the runoff rate, helps control erosion, and improves the rate of water infiltration.

This soil is suited to range. The native vegetation is predominantly little bluestem, big bluestem, and sideoats grama. Overgrazing reduces the vigor and growth of these grasses, and causes the invasion of less productive grasses and weeds. Proper stocking rates, uniform distribution of livestock, and deferred grazing help keep the range in good condition. Range seeding is needed to restore productivity on abandoned cropland.

In many areas of this map unit, rangeland is adjacent to cropland. Shrub plantings along the cropland-rangeland edge provide needed winter cover for upland wildlife, such as pheasant.

This soil is moderately well suited to local roads and streets and to dwellings. Low strength is a limitation for local roads and streets, and shrink-swell potential is a limitation for dwellings. Roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for low strength of the soil material. Coarse-grained base material can be used to reduce damage caused by shrinking and swelling of the soil. For dwellings, properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material reduce damage caused by low strength and by shrinking and swelling of the soil. Depth to bedrock is also a limitation for dwellings with basements, but the rock is generally soft and can be easily excavated.

The soil is generally unsuited to septic tank absorption fields because of slow permeability and depth to bedrock. It is poorly suited to sewage lagoons. The construction of sewage lagoons requires borrowing soil or ripping because of the moderate depth to bedrock. The bottom of the lagoon may need to be sealed to prevent excessive seepage into fractures in the bedrock. Deeper soils included in this map unit on lower slopes are better suited. If less sloping soils are selected, lagoon construction requires less leveling and banking.

The capability subclass of this soil is IIIe, and the range site is Limy Upland.

Cr—Clime stony silty clay loam, 15 to 30 percent slopes. This moderately deep, moderately steep, well drained soil is on upland breaks and side slopes. Individual areas are irregular in shape and range from 100 to 300 acres in size. These areas have numerous limestone rocks scattered over the surface. They range from 1 foot to 3 feet in diameter and from 5 to 50 feet apart.

Typically, the surface layer is very dark gray, calcareous stony silty clay loam about 7 inches thick. The subsoil is pale brown, firm, calcareous silty clay loam about 8 inches thick. The substratum is pale yellow, very firm, calcareous silty clay. Calcareous shale is at a depth of about 23 inches. In places, the depth to shale is less than 20 inches.

Included with this soil in mapping and making up about 20 percent of the map unit are small areas of shallow Sogn soils and deep Tully soils. Sogn soils are on narrow ridgetops near the breaks. Tully soils are on foot slopes below Clime soils.

Permeability in this Clime soil is slow, and available water capacity is low. Runoff is rapid. Natural fertility is medium, and organic matter content is moderate. The surface layer is moderately alkaline. Root development is restricted below a depth of about 23 inches. The subsoil has moderate shrink-swell potential.

This soil is best suited to range, and nearly all of its acreage is used for range. This soil is unsuited to cultivated crops because of the severe hazard of erosion and the many stones on the surface. The cover consists of brush and trees (fig. 7). In some places, prolonged overgrazing causes desirable tall grasses to decrease and shorter grasses, woody plants, weeds, and trees to increase. Range management practices that maintain an adequate vegetative cover help reduce runoff and excessive soil losses. Proper stocking rates, uniform distribution of livestock, and deferred grazing help keep the range in good condition. Prescribed burning in late spring helps keep the number of woody plants at an acceptable level.

Figure 7.—Brush and weeds have invaded some areas of this Clime stony silty clay loam, 15 to 30 percent slopes. Woody plants are along the steeper side slopes.

This soil is generally unsuited to building sites because of moderately steep slopes.

The capability subclass of this soil is VIIe, and the range site is Limy Upland.

Cs—Clime-Sogn silty clay loams, 3 to 20 percent slopes. This map unit consists of moderately deep, well drained Clime soil and shallow or very shallow, somewhat excessively drained Sogn soil on narrow ridgetops and side slopes. The strongly sloping Clime soil is on side slopes below ridgetops. The gently sloping Sogn soil is on ridgetops above the Clime soil. Many rock outcrops are near the ridgetops. Individual areas are irregular in shape and range from 20 to 250 acres in size. About 65 percent of the map unit is Clime soils, and 20 percent is Sogn soils. The areas of these two soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping.

Typically, the Clime soil has a very dark gray, calcareous silty clay loam surface layer about 7 inches thick. The subsoil is pale brown, firm, calcareous silty clay loam about 13 inches thick. The substratum is pale yellow, calcareous silty clay. Calcareous shale is at a depth of about 27 inches. In places, the surface layer is stony silty clay loam (fig. 8). In other places, the depth to shale is less than 20 inches.

Typically, the Sogn soil has a very dark gray silty clay loam surface layer about 8 inches thick. Limestone is below the surface layer. In some places, the surface layer contains fragments of limestone.

Included with these soils in mapping and making up about 15 percent of the map unit are small areas of Labette and Tully soils and outcrops of shale and

Figure 8.—In this area of Clime-Sogn clay loams, 3 to 20 percent slopes, limestone rocks cover many areas of the Clime soil. Rock outcrops on the ridges are in an area of Sogn soil, and trees are in an area of Verdigris silt loam, channeled.

limestone. The moderately deep, well drained Labette soils are on the ridgetops, and the deep, well drained Tully soils are on lower side slopes below the Clime soils. Outcrops of limestone and shale are near breaks of the ridgetops.

The Clime soil has slow permeability and moderate available water capacity. The Sogn soil has moderate permeability and very low available water capacity. Runoff is rapid. These soils have medium natural fertility. Organic matter content is moderate. Root development is restricted below a depth of 27 inches in the Clime soil and below a depth of about 9 inches in the Sogn soil. The shrink-swell potential of the subsoil is moderate in the Clime soil.

These soils are best suited to rangeland, and nearly all of the acreage of this map unit is used for rangeland. These soils are generally unsuited to cultivated crops because of the severe hazard of erosion and the shallow depth to limestone. The native vegetation is dominantly little bluestem and big bluestem. Sideoats grama is most common on the shallow Sogn soil. In severely overgrazed areas, the range is invaded by annual bromegrass, annual broomweed, and other less desirable vegetation. Management that maintains an adequate vegetative cover helps conserve moisture by reducing runoff. In many areas some form of brush control is needed. Proper stocking rates, uniform distribution of livestock, timely deferment of grazing or use of a rotational grazing system, and timely burning help keep the range in good condition and prevent the encroachment of brush.

The Clime soil is poorly suited to local roads and streets and to dwellings. If it is used as sites for local roads and streets, low strength is a major limitation. Slope is a limitation in the steeper areas. Roads and

streets should be designed so that the surface pavement and base material are thick enough to compensate for low strength of the soil material. Coarse-grained base material can be used to reduce damage caused by shrinking and swelling of the soil. Less sloping areas make better sites for roads, and building roads on the contour reduces the hazard of erosion. If this soil is used as sites for dwellings, depth to bedrock and slope are limitations. Land shaping is commonly needed. In most places, the bedrock is soft and can be easily excavated. Deeper, less sloping soils on foot slopes are more favorable sites for dwellings.

The Clime soil is generally unsuited to septic tank absorption fields because of slow permeability and depth to rock. It is poorly suited to sewage lagoons because of slope and depth to rock. Constructing sewage lagoons requires borrowing soil or ripping because of the moderate depth to bedrock. The bottom of the lagoon may need to be sealed to prevent excessive seepage into fractures in the bedrock. Deeper, less sloping soils on foot slopes are more favorable sites for lagoons. Construction in these areas requires less leveling and banking.

The Sogn soil is generally unsuited to building sites because of depth to bedrock.

The capability subclass of this map unit is VIe. The Clime soil is in the Limy Upland range site, and the Sogn soil is in the Shallow Limy range site.

Dw—Dwight silt loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on ridgetops and upper side slopes near limestone rock outcrops. Individual areas are irregular in shape and range from 20 to 100 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsoil is about 31 inches thick. The upper part is dark grayish brown, very firm silty clay. The middle part is brown, extremely firm silty clay. The lower part is brown, very firm silty clay and contains some fine lime concretions. The substratum is brown, mottled silty clay. Hard limestone is at a depth of about 56 inches. In places, the surface layer is light gray. Also, in some areas where the upper part of the subsoil has been mixed with the surface soil by tillage, the surface layer is silty clay.

Included with this soil in mapping and making up about 10 percent of the map unit are small areas of Labette soils on similar slopes. The moderately deep Labette soils have a thicker surface layer than does the Dwight soil.

Permeability in this Dwight soil is very slow, and available water capacity is moderate. Runoff is medium. The surface layer is slightly acid. The subsoil contains enough sodium to adversely affect the growth of most plants. Natural fertility is medium, and organic matter content is moderate. The subsoil has high shrink-swell potential.

About 75 percent of the acreage of this soil is used for range, and the remaining acreage is used for cultivated crops. This soil is poorly suited to cultivated crops. Wheat, grain sorghum, and alfalfa are the main crops grown. This soil is droughty, making it difficult to establish crops. Erosion is a hazard on the sloping areas. The surface layer is thin and commonly becomes mixed with the clayey subsoil when cultivated. Crop residue management helps improve tilth and increase infiltration. Minimum tillage, terraces, and contour farming help to control runoff and erosion.

This soil is best suited to native range. Range in good condition includes a mixture of tall, mid, and short grasses. Overused areas are dominated by short grasses, such as buffalograss and blue grama. They are also invaded by weeds that include prairie threeawn and annual broomweed. Proper stocking rates, uniform distribution of livestock, timely deferment of grazing, prescribed burning, and restricting use during wet periods help keep the range in good condition. Range seeding is needed to restore productivity on abandoned cropland.

The shorter vegetation common to this soil provides preferred booming ground for prairie chickens. Range management that provides tall grass in nearby areas for nesting benefits prairie chicken populations.

This soil is moderately well suited to local roads and streets and to dwellings. Shrink-swell potential is a limitation for both uses, and low strength is a limitation for local roads and streets. Roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for low strength of the soil material. Coarse-grained base material can be used to reduce damage caused by shrinking and swelling of the soil. For dwellings, properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material reduce damage caused by low strength and by shrinking and swelling of the soil.

This soil is generally unsuited to septic tank absorption fields because of very slow permeability. It is moderately well suited to sewage lagoons. Constructing sewage lagoons requires borrowing soil or ripping because of the moderate depth to bedrock. The bottom of the lagoon may need to be sealed to prevent excessive seepage into fractures in the bedrock. The soils deepest over bedrock make the best sites for lagoons.

The capability subclass of this soil is IVs, and the range site is Claypan.

Ed—Edalgo silty clay loam, 3 to 12 percent slopes. This moderately deep, moderately sloping and strongly sloping, well drained soil is on ridgetops and side slopes. Individual areas are irregular in shape and range from 30 to 200 acres in size.

Typically, the surface layer is grayish brown silty clay loam about 10 inches thick. The subsoil is about 14

inches thick. The upper part is brown, firm silty clay. The lower part is brown, mottled, very firm silty clay. The substratum is grayish brown, mottled silty clay. Shale is at a depth of about 34 inches. In places, the depth to shale is more than 40 inches. In some areas, the surface layer and subsoil contain fragments of sandstone or ironstone.

Included with this soil in mapping and making up about 10 percent of the map unit are small areas of Hedville and Lancaster soils and outcrops of sandstone rock. The shallow Hedville soils are on upper side slopes. The loamy Lancaster soils, which have sandstone rock at a depth of 20 to 40 inches, are on similar side slopes. Outcrops of sandstone rock are in the steeper areas.

Permeability in this Edalgo soil is very slow, available water capacity is low, and surface runoff is rapid. Natural fertility is medium, and the organic matter content is moderate. The surface layer is medium acid. Root development is restricted below a depth of about 34 inches. The subsoil has high shrink-swell potential.

This soil is best suited to rangeland. About 80 percent of its acreage is used for range, and the rest is used for cultivated crops. It is generally unsuited to cultivated crops because of the severe hazard of erosion. If the range site is in good condition, the main grasses are big bluestem, little bluestem, and switchgrass. Overgrazing reduces the growth and vigor of the grasses and increases runoff. Prolonged overgrazing causes desirable tall grasses to decrease and shorter grasses, woody plants, and weeds to increase. Range management practices that maintain an adequate vegetative cover help reduce runoff and excessive soil loss. Proper stocking rates, uniform distribution of livestock, and deferred grazing help keep the range in good condition.

This soil is poorly suited to local roads and to dwellings because of the shrink-swell potential. Low strength is an additional limitation for local roads. Roads should be designed so that the surface pavement and base material are thick enough to compensate for low strength of the soil material. Coarse-grained base material can be used to reduce damage caused by shrinking and swelling of the soil. For dwellings, properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material reduce damage caused by low strength and by shrinking and swelling of the soil.

This soil is generally unsuited to septic tank absorption fields because of very slow permeability and depth to rock. It is poorly suited to sewage lagoons because of depth to bedrock and slope. Constructing sewage lagoons requires borrowing soil or ripping because of the moderate depth to bedrock. The bottom of the lagoon may need to be sealed to prevent excessive seepage into fractures in the bedrock. Construction in less sloping areas requires less leveling and banking.

The capability subclass of this soil is VIe, and the range site is Clay Upland.

Fc—Florence silt loam, 2 to 15 percent slopes. This deep, gently sloping to strongly sloping, well drained soil is on convex ridgetops and side slopes. Individual areas are irregular in shape and range from 100 to 500 acres in size.

Typically, the surface soil is very dark gray silt loam about 13 inches thick. The subsoil is about 32 inches thick. The upper part is dark brown, very firm, cherty silty clay loam. The lower part is reddish brown, very firm, extremely cherty clay. Cherty limestone is at a depth of about 45 inches. In places, the depth to cherty limestone is less than 40 inches. In places, chert fragments are on the surface.

Included with this soil in mapping and making up about 10 to 15 percent of the map unit are small areas of Dwight, Labette, and Tully soils and outcrops of limestone rock. These soils do not have a cherty clay subsoil. The deep Dwight soils and moderately deep Labette soils are on ridgetops. The deep Tully soils are on foot slopes. Limestone rock outcrops are on narrow ridgetops.

Permeability in this Florence soil is moderately slow, and available water capacity is low. Runoff is rapid. This soil has medium natural fertility and moderate organic matter content. The surface layer is slightly acid. The subsoil has moderate shrink-swell potential. Root development is restricted below a depth of about 45 inches.

This soil is best suited to range, and nearly all of its acreage is used for range. The soil is generally unsuited to cultivated crops because erosion is a severe hazard. In some places, chert fragments interfere with tillage. The native vegetation is predominantly big bluestem, little bluestem, and indiangrass. Overgrazing reduces vegetative cover and causes deterioration of the plant community. Under these conditions, the taller grasses are replaced by less productive grasses and weeds, such as tall dropseed, Baldwin ironweed, and western ragweed. Proper stocking rates, uniform distribution of livestock, and timely deferment of grazing help keep the range in good condition.

This soil is moderately well suited to dwellings and to local roads and streets. Slope and shrinking and swelling of the soil are limitations if the soil is used for dwellings. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material around the foundations of buildings help reduce damage caused by shrinking and swelling of the soil. Less land shaping is needed if the less sloping ridgetops are selected as building sites. Chert fragments may interfere with excavation and filling during construction. Dwellings with basements are limited by depth to bedrock, and should be constructed in the areas deepest to bedrock. Roads should be designed so that the surface pavement and base material are thick enough to compensate for low strength of the soil material.

The soil is generally unsuited to septic tank absorption fields because of the moderately slow permeability. It is poorly suited to sewage lagoons because of slope. Construction in less sloping areas requires less leveling and banking. Depth to bedrock can also be a limitation in some places. The deep included soils on foot slopes commonly are better sites for sewage lagoons.

The capability subclass of this soil is VIe, and the range site is Loamy Upland.

Go—Goessel silty clay. This deep, nearly level, moderately well drained soil is on broad upland ridgetops. Individual areas are irregular in shape and range from 30 to several hundred acres in size.

Typically, the surface layer is very dark gray silty clay about 6 inches thick. The subsurface layer is very dark gray silty clay about 7 inches thick. The next layer is about 29 inches thick. The upper part is dark gray, firm silty clay. The middle part is gray, mottled, extremely firm clay. The lower part is grayish brown, mottled, very firm clay. The substratum to a depth of about 60 inches is light brownish gray, mottled clay that contains some lime concretions. In places, strata of sandy loam or sandy clay loam are below a depth of 30 inches.

Included with this soil in mapping and making up about 10 percent of the map unit are small areas of Wells and Rosehill soils. The well drained Wells soils have a less clayey surface layer and subsoil. They are on small knolls above the Goessel soil. The moderately deep Rosehill soils are on side slopes below the Goessel soil.

Permeability in this Goessel soil is very slow, and runoff is slow. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. The surface layer is very firm and is difficult to till. If the soil is tilled when it is too wet or too dry, clods form and structure is destroyed. A perched seasonal high water table is at a depth of 2 to 3 feet. Reaction in the surface layer is neutral. The subsoil has high shrink-swell potential.

Nearly all of the acreage of this soil is used for cultivated crops. This soil is moderately well suited to wheat, grain sorghum, and soybeans. It is less well suited to alfalfa, which is often used in the rotation. This soil is droughty in the summer because the clayey soil releases water slowly. Measures that improve tilth are needed. Using minimum tillage and leaving crop residue on the surface help to improve tilth and conserve moisture. Wetness in the spring may delay tillage. Some areas need surface drainage.

This soil is poorly suited to dwellings and to local roads and streets. Shrink-swell potential is a limitation for both uses. Properly designing and reinforcing foundations and backfilling with porous material reduce damage to buildings caused by shrinking and swelling of the soil. Wetness can be a limitation for dwellings with basements. Footing drains and sump pumps can reduce or overcome seepage. Roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for low strength of the soil material. Coarse-grained base material can be used to reduce damage caused by shrinking and swelling of the soil.

This soil is generally unsuited to septic tank absorption fields because of very slow permeability and wetness. It is well suited to sewage lagoons.

The capability subclass of this soil is IIs, and the range site is Clay Upland.

Ib—Irwin silty clay loam, 1 to 3 percent slopes. This deep, gently sloping, moderately well drained soil is on broad ridgetops and side slopes. Individual areas are irregular in shape and range from 20 to 300 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 7 inches thick. The subsurface layer is dark grayish brown, firm silty clay loam about 6 inches thick. The subsoil is very firm silty clay about 27 inches thick. The upper part is dark brown, and the lower part is brown and contains a few fine lime concretions. The substratum to a depth of about 60 inches is brown, mottled silty clay. In some areas, where the upper part of the subsoil has been mixed with the surface soil by tillage, the surface layer is silty clay.

Included with this soil in mapping and making up about 10 to 15 percent of the map unit are small areas of Clime and Dwight soils. The Clime soils, which are along drainageways on lower slopes, are calcareous and are underlain by shale at a depth of 20 to 40 inches. Dwight soils are sodic, have a thin silt loam surface layer, and are on upper slopes.

Permeability in this Irwin soil is very slow, and available water capacity is high. Runoff is medium. Natural fertility is medium, and organic matter content is moderate. Tilth is good. The surface layer is slightly acid. The subsoil has high shrink-swell potential.

Nearly all of the acreage of this soil is used for cultivated crops. This soil is well suited to wheat, grain sorghum, and soybeans. It is less well suited to alfalfa, which is often used in the rotation. Erosion is a hazard if cultivated crops are grown. This soil is droughty in the summer because the clayey subsoil releases water slowly. Terraces, grassed waterways, contour farming, leaving crop residue on the surface, and minimum tillage help reduce erosion and maintain organic matter content and good tilth (fig. 9).

This soil is moderately suited to dwellings and to local roads and streets. Shrink-swell potential is a limitation for both uses. In addition, low strength limits the use of this soil for local roads and streets. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse material reduce structural damage to buildings caused by shrinking and swelling of the soil. Roads and streets should be designed so that the surface pavement and base material are thick

enough to compensate for low strength of the soil material. Coarse-grained base material can be used to reduce damage caused by shrinking and swelling of the soil.

The soil is generally unsuited to septic tank absorption fields because of very slow permeability. It is well suited to sewage lagoons; however, some land shaping is commonly needed.

The capability subclass of this soil is IIe, and the range site is Clay Upland.

Ic—Irwin silty clay loam, 3 to 6 percent slopes. This deep, moderately sloping, moderately well drained soil is on side slopes. Individual areas are irregular in shape and range from 50 to 150 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 9 inches thick. The subsoil is very firm silty clay about 27 inches thick. The upper part is dark brown, and the lower part is brown and contains some fine lime concretions. The substratum to a depth of about 60 inches is brown, mottled silty clay. In other places, where the upper part of the subsoil has been mixed with the surface layer by tillage, the surface layer is silty clay and lighter colored.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Clime and Labette soils. These soils are on upper slopes near ridgetops. Clime soils are calcareous and are underlain by shale at a depth of 20 to 40 inches. Labette soils are underlain by limestone at a depth of 20 to 40 inches.

Permeability in this Irwin soil is very slow, and available water capacity is high. Runoff is rapid. Natural fertility is medium, and organic matter content is moderate. Tilth is good. The surface layer is slightly acid. The subsoil has high shrink-swell potential.

About 70 percent of the acreage of this soil is used for cultivated crops, and the rest of the acreage is used for rangeland. This soil is moderately well suited to wheat, grain sorghum, soybeans, and alfalfa. If the soil is used for cultivated crops, there is a hazard of erosion. The soil is droughty in the summer because the clayey subsoil releases water slowly. Terraces, grassed waterways, contour farming, leaving crop residue on the surface, and minimum tillage help reduce erosion and maintain organic matter content and good tilth.

The native vegetation is predominantly big bluestem, little bluestem, switchgrass, and sideoats grama. Overgrazing reduces vegetative cover and causes deterioration of the plant community. Under these conditions the taller grasses are replaced by less productive grasses and weeds. Proper stocking rates, uniform distribution of livestock, timely deferment of grazing and burning, and a rotational grazing system help keep the range in good condition.

This soil is poorly suited to local roads and streets and to dwellings because of the shrink-swell potential and low strength. Roads and streets should be designed so that the surface pavement and base material are thick enough to prevent the damage resulting from shrinking and swelling and from low strength. Coarse-grained base material can be used to reduce damage caused by shrinking and swelling of the soil. For dwellings, properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by low strength and by shrinking and swelling of the soil.

This soil is generally unsuited to septic tank absorption fields because of very slow permeability. It is moderately well suited to sewage lagoons; however, slope is a limitation. Some land shaping is commonly needed. Construction in less sloping areas requires less leveling and banking.

The capability subclass of this soil is IIIe, and the range site is Clay Upland.

Kp—Kipson silty clay loam, 10 to 25 percent slopes. This shallow, strongly sloping and moderately steep, somewhat excessively drained soil is on narrow ridgetops and side slopes. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is grayish brown, calcareous silty clay loam about 9 inches thick. The next layer is light yellowish brown, friable, calcareous silty clay loam about 7 inches thick. The substratum is pale brown, calcareous shaly silty clay loam. Calcareous shale is at a depth of about 20 inches. In places, the depth to shale is 20 to 40 inches, and the substratum is silty clay. In other places, the substratum contains thin layers of limestone.

Included with this soil in mapping and making up about 10 percent of the map unit are small areas of Hedville soils and shale rock outcrops. Hedville soils are on ridgetops and steeper side slopes. They contain more sand and are underlain by sandstone at a depth of 4 to 20 inches. Outcrops of shale are on ridgetops and upper side slopes.

Permeability in this Kipson soil is moderate, and available water capacity is low. Runoff is rapid. Natural fertility is low, and organic matter content is moderate. The soil has moderate shrink-swell potential. Root development is restricted below a depth of about 20 inches.

This soil is generally unsuited to cultivated crops because of the severe hazard of erosion. It is suited to range, and most areas are used for rangeland. The predominant native vegetation is big bluestem, little bluestem, and sideoats grama. Prolonged overgrazing causes desirable tall grasses to decrease and shorter grasses, woody plants, and weeds to increase. Controlled burning may be needed in some years to control brush. Proper stocking rates, uniform distribution of livestock, and deferred grazing help keep the range in good condition.

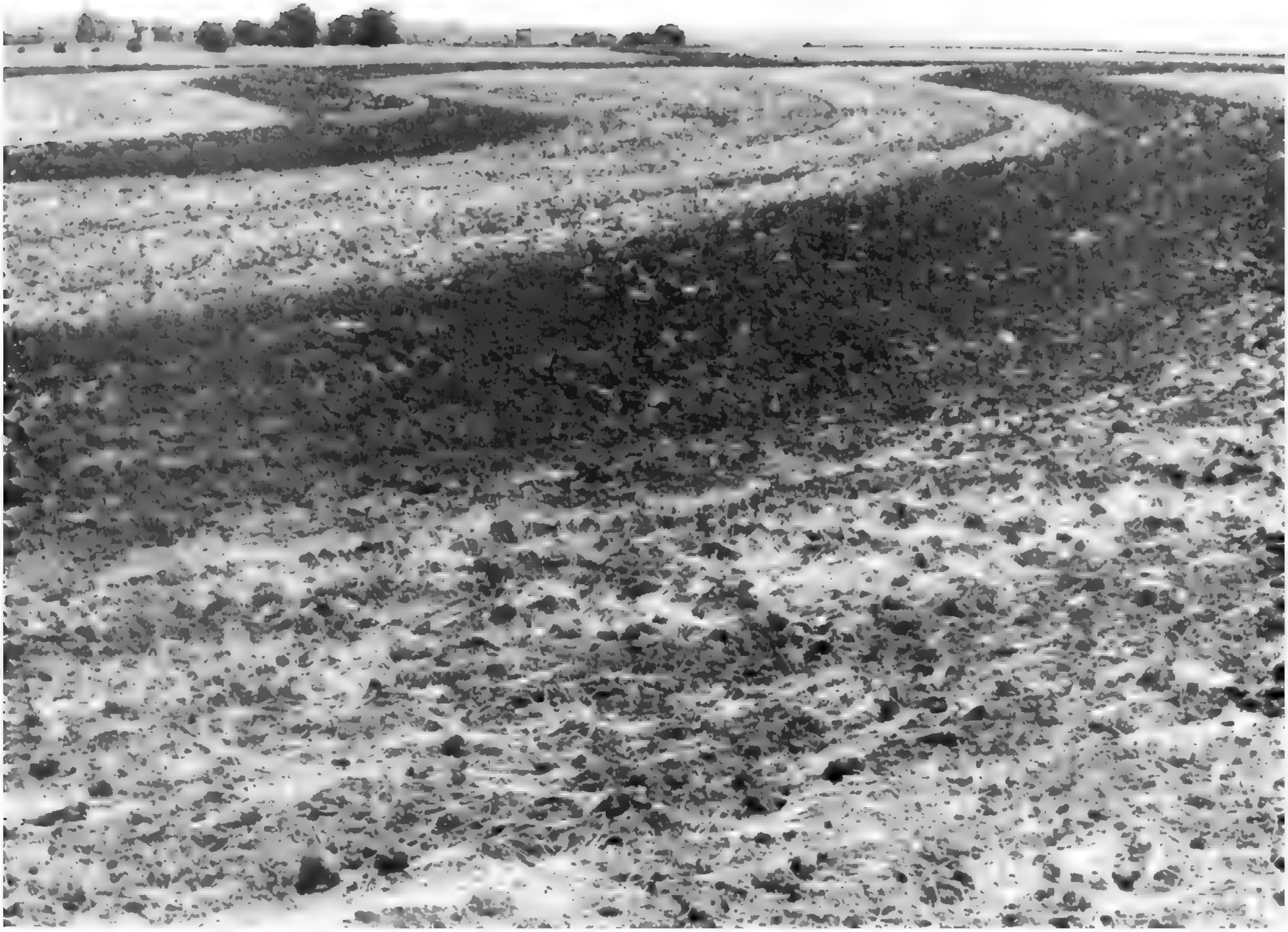

Figure 9.—Terracing, contour farming, and leaving crop residue on the soil's surface help prevent erosion in this area of Irwin silty clay loam, 1 to 3 percent slopes.

This soil is generally unsuited to building site development because of shallowness to bedrock and the moderately steep slope.

The capability subclass of this soil is VIe, and the range site is Limy Upland.

La—Labette silty clay loam, 1 to 4 percent slopes. This moderately deep, gently sloping, well drained soil is on ridgetops and upper side slopes. Individual areas are irregular in shape and range from 30 to 100 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 8 inches thick. The subsurface layer is dark grayish brown, firm silty clay loam about 7 inches thick. The subsoil is about 16 inches thick. The upper part is dark brown, very firm silty clay. The lower part is brown, very firm silty clay that contains a few fine lime concretions. The substratum is brown silty clay that contains a few small fragments of limestone. Hard limestone is at a depth of about 36 inches. In places, the depth to limestone is more than 40 inches. Also, in some areas where the upper part of the subsoil has been mixed with the surface soil by tillage, the surface layer is dark brown or brown.

Included with this soil in mapping and making up about 10 percent of the map unit are small areas of Dwight and Sogn soils. The sodic Dwight soils have a thin silt loam surface layer and are on slopes similar to those of

the Labette soils. The shallow Sogn soils are on upper side slopes.

Permeability is slow in this Labette soil, and available water capacity is moderate. Runoff is medium. Tilth is good. Natural fertility is medium, and organic matter content is moderate. Root development is restricted below a depth of about 36 inches. The surface layer is slightly acid. The subsoil has high shrink-swell potential.

About half of the acreage of this soil is used for cultivated crops, and the remaining acreage is used for range. This soil is moderately well suited to wheat, grain sorghum, and soybeans. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, leaving crop residue on the surface, and minimum tillage help reduce erosion and maintain organic matter content and good tilth. In a few places, constructing terraces removes most of the soil overlying the bedrock, thereby severely reducing the root zone for plants. Depth to bedrock should be considered when designing a terrace system.

This soil is suited to range. The native vegetation is predominantly big bluestem, little bluestem, switchgrass, and indiangrass. In overused areas, less desirable plants, such as Baldwin ironweed and western ragweed, invade the range. Proper stocking rates, rotational grazing, and timely deferment of grazing help keep the range in good condition. Invasion of brushy plants, such as sumac and eastern red cedar, is a concern of management. Timely burning helps control brush and trees. Range seeding is needed to restore productivity on abandoned cropland.

This soil is moderately well suited to dwellings and to local roads and streets. The shrink-swell potential is a limitation for dwellings. Depth to bedrock is also a limitation to dwellings with basements. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material around the foundation help to reduce damage to buildings caused by shrinking and swelling of the soil. The areas in which the depth to bedrock is more than 40 inches can generally be used as sites for dwellings with basements. Low strength and shrink-swell potential are limitations for local roads and streets. Roads should be designed so that the surface pavement and base material are thick enough to compensate for low strength of the soil material. Coarse-grained base material can be used to reduce damage caused by shrinking and swelling of the soil.

This soil is generally unsuited to septic tank absorption fields because of the depth to bedrock. It is poorly suited to sewage lagoons. Constructing sewage lagoons requires borrowing soil or ripping because of the moderate depth to bedrock. The bottom of the lagoon may need to be sealed to prevent excess seepage into fractures in the bedrock.

The capability subclass of this soil is IIe, and the range site is Loamy Upland.

Ld—Labette-Dwight complex, 1 to 3 percent slopes. These moderately deep, well drained Labette soils and deep, moderately well drained Dwight soils are on broad ridgetops. These soils are gently sloping. Individual areas of this unit are irregular in shape and range from 40 to several hundred acres in size. About 60 percent of this map unit is Labette soils, and 35 percent is Dwight soils. The areas of these soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping.

Typically, the Labette soils have a dark grayish brown silty clay loam surface layer about 7 inches thick. The subsurface layer is dark grayish brown, firm silty clay loam about 13 inches thick. The subsoil is about 16 inches thick. The upper part is dark brown, very firm silty clay. The lower part is brown, very firm silty clay that contains a few fine lime concretions. The substratum is brown silty clay that contains a few small fragments of limestone. Hard limestone is at a depth of about 36 inches. In some places, the depth to limestone is more than 40 inches.

Typically, the Dwight soils have a dark grayish brown silt loam surface layer about 6 inches thick. The subsoil is about 30 inches thick. The upper part is dark grayish brown, very firm silty clay. The middle part is brown, extremely firm silty clay. The lower part is brown, very firm silty clay that contains some fine lime concretions. The substratum is brown, mottled, very firm silty clay. Hard limestone bedrock is at a depth of about 56 inches. In places, the surface layer is lighter colored.

Included with these soils in mapping and making up about 5 percent of the map unit are small areas of Sogn soils and outcrops of limestone rock. Sogn soils are underlain by limestone at a depth of less than 20 inches. They are intermingled with the limestone rock outcrops on upper side slopes.

Labette soils have slow permeability and moderate available water capacity. Dwight soils have very slow permeability and moderate available water capacity. Surface runoff is medium. These soils have medium natural fertility and moderate organic matter content. Tilth is good. The surface layer is slightly acid. The subsoil of the Dwight soils contains enough sodium to adversely affect the growth of most plants. The Dwight soils do not absorb moisture easily or release it readily to plants. In the Labette soils, root development is restricted below a depth of about 36 inches. The subsoil of both soils has high shrink-swell potential.

About 50 percent of the acreage of these soils is used for cultivated crops, and the remaining acreage is used for range. These soils are moderately well suited to wheat, grain sorghum, and soybeans. Erosion is a hazard if the soils are cultivated. The soils are droughty in the summer because the subsoil releases water slowly. Terraces, waterways, contour farming, crop residue management, and minimum tillage help reduce erosion and maintain organic matter content and good

tilth. During dry seasons, it is difficult to establish crops on the more alkaline spots. Leaving crop residue on the surface helps to improve the rate of water infiltration. Proper use of fertilizers and crop residue helps to maintain fertility and organic matter content and tilth.

These soils are suited to range. The native vegetation is predominantly big bluestem, little bluestem, indiangrass, and switchgrass on the Labette soils, and little bluestem, switchgrass, and sideoats grama on the Dwight soils. Overused areas are dominated by short grasses, such as buffalograss and blue grama. These areas are also invaded by weeds that include prairie threeawn. Proper stocking rates, uniform distribution of livestock, timely deferment of grazing and burning, restricting use during wet periods, and a rotational grazing system help to keep the range in good condition. Range seeding is needed to restore productivity on abandoned cropland.

The diverse vegetation common to areas of these soils provides good habitat for prairie chickens. The short grasses on Dwight soils are favorite sites for booming grounds. Good range management helps maintain good growth of tall native grasses, providing nesting areas for prairie chickens.

These soils are moderately well suited to dwellings and to local roads and streets. The shrink-swell potential is a limitation for dwellings. On the Labette soils, depth to bedrock is an additional limitation for dwellings with basements. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material around the foundation help to reduce damage caused by shrinking and swelling of the soil. The deep Dwight soils are better sites for dwellings with basements. Low strength and the shrink-swell potential are limitations for local roads and streets. Roads should be designed so that the surface pavement and base material are thick enough to compensate for low strength of the soil material. Coarse-grained base material can be used to prevent damage caused by shrinking and swelling of the soil.

These soils are generally unsuited to septic tank absorption fields because of very slow permeability or depth to bedrock. The deep Dwight soils are better sites for sewage lagoons than the moderately deep Labette soils.

The capability subclass of these soils is IIIe. The range site for the Labette soils is Loamy Upland, and the range site for the Dwight soils is Claypan.

Lg—Labette-Sogn silty clay loams, 2 to 15 percent slopes. This map unit consists of moderately deep, well drained Labette silty clay loam and shallow, somewhat excessively drained Sogn silty clay loam. These soils are on ridgetops and side slopes and are gently sloping to strongly sloping. Individual areas are irregular in shape and range from 40 to several hundred acres in size. About 65 percent of this map unit is Labette soil, and 25 percent is Sogn soil. The Sogn soil is on the steeper slopes of the map unit. The areas of these two soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping.

Typically, the Labette soil has a dark grayish brown silty clay loam surface layer about 7 inches thick. The subsurface layer is dark grayish brown, firm silty clay loam about 16 inches thick. The subsoil is about 16 inches thick. The upper part is dark brown, very firm silty clay. The lower part is brown, very firm silty clay that contains a few fine lime concretions. The substratum is brown silty clay that contains a few small fragments of limestone. Hard limestone is at a depth of about 36 inches. In places, the depth to limestone is more than 40 inches.

Typically, the Sogn soil has a very dark gray silty clay loam surface layer about 10 inches thick. Limestone underlies the surface layer. In some places, fragments of limestone are in the surface layer.

Included with these soils in mapping and making up about 10 percent of the map unit are small areas of Dwight soils and limestone rock outcrops. The salt-affected Dwight soils are on a similar position in the landscape. Outcrops of limestone rock are in the steeper areas. Small sinkholes are common in this map unit.

Labette soils have slow permeability and moderate available water capacity. Sogn soils have moderate permeability and very low available water capacity. Surface runoff is rapid. The Sogn soil has low natural fertility, and the Labette soil has medium natural fertility. Organic matter content is moderate in both soils. Root development is restricted below a depth of about 34 inches in the Labette soil and about 10 inches in the Sogn soil. The Labette subsoil has high shrink-swell potential, and the Sogn soil has moderate shrink-swell potential.

Nearly all of the acreage of these soils is used for rangeland. These soils are generally unsuited to cultivated crops because of a severe hazard of erosion. In addition, rockiness interferes with tillage. These soils are best suited to rangeland. The predominant native grasses on the Labette soil are big bluestem, little bluestem, and indiangrass. Little bluestem and sideoats grama are more common on the Sogn soil. Overgrazing reduces vegetative cover and causes deterioration of the plant community. Under these conditions the taller grasses are replaced by less productive grasses and weeds. Proper stocking rates, uniform distribution of livestock, and a rotational grazing system help keep the range in good condition. Some areas are invaded by brushy plants, such as osageorange and sumac, and need brush control to improve grass production. Burning in late spring helps control the growth of woody plants.

The Labette soil is moderately well suited to dwellings and to local roads and streets. The shrink-swell potential is a limitation for dwellings. Depth to rock is a limitation for dwellings with basements. Using properly designed

and reinforced foundations, installing foundation drains, and backfilling with porous material around the foundation help to reduce damage caused by shrinking and swelling of the soil. The areas in which the depth to bedrock is more than 40 inches generally can be used as sites for dwellings with basements. Roads should be designed so that the surface pavement and base material are thick enough to compensate for low strength of the soil material. Coarse-grained base material can be used to prevent damage caused by shrinking and swelling of the soil.

The Labette soil is generally unsuited to septic tank absorption fields because of the depth to bedrock. It is poorly suited to sewage lagoons. Constructing sewage lagoons requires borrowing soil or ripping because of the moderate depth to bedrock. The bottom of the lagoon may need to be sealed to prevent excessive seepage into fractures in the bedrock. Deeper soils on adjacent foot slopes are more favorable sites for lagoons.

The Sogn soil is generally unsuited to building sites because of the shallowness to bedrock.

The capability subclass of these soils is VIe. The range site for the Labette soil is Loamy Upland, and the range site for the Sogn soil is Shallow Limy.

Lm—Ladysmith silty clay loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on broad upland flats and ridgetops. Individual areas are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is dark gray silty clay loam about 9 inches thick. The subsoil is about 43 inches thick. The upper part is dark gray, very firm silty clay. The middle part is gray, mottled, very firm silty clay. The lower part is grayish brown, mottled, very firm silty clay that contains a few fine lime concretions. The substratum to a depth of about 60 inches is light brownish gray, mottled, silty clay that contains a few fine lime concretions. In some places, the surface layer is silty clay, and in some places, the subsoil is brown.

Included with this soil in mapping and making up about 10 percent of the map unit are small areas of Wells soils. These well drained and loamy soils are on small mounds above Ladysmith soils.

Permeability in this Ladysmith soil is very slow, and runoff is slow. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. Tilth is fair. A perched seasonal high water table is at a depth of 2 to 3 feet. The surface layer is medium acid. The subsoil has high shrink-swell potential.

Nearly all of the acreage of this soil is used for cultivated crops. This soil is well suited to wheat, grain sorghum, and soybeans. It is less well suited to alfalfa, but this crop is often used in the crop rotation. The main management concern is maintaining soil tilth, organic matter content, and fertility. The soil is droughty during the summer because the clayey subsoil releases water slowly. Minimum tillage, crop residue management, and fertilization are management practices that help conserve moisture and maintain organic matter content, fertility, and tilth. Tillage operations may be delayed in spring because of wetness. Some areas need surface drainage.

This soil is moderately well suited to dwellings and to roads and streets. Shrink-swell potential is a limitation for both uses. Damage to buildings caused by shrinking and swelling of the soil can be reduced by properly designing and reinforcing foundations and backfilling with suitable coarse material. Wetness is a problem for dwellings with basements. Footing drains and sump pumps can reduce or overcome seepage. Roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for low strength of the soil material. Coarse-grained base material can be used to reduce damage to roads caused by shrinking and swelling of the soil.

This soil is generally unsuited to septic tank absorption fields because of very slow permeability and wetness. It is well suited to sewage lagoons.

The capability subclass of this soil is IIs, and the range site is Clay Upland.

Ls—Lancaster loam, 1 to 3 percent slopes. This moderately deep, gently sloping, well drained soil is on ridgetops and side slopes of uplands. Sandstone rocks ranging from 6 inches to 1 foot in diameter are commonly 30 to 200 feet apart on the surface. Individual areas are irregular in shape and range from 20 to 100 acres in size.

Typically, the surface layer is brown loam about 7 inches thick. The subsoil is about 28 inches thick. The upper part is brown, friable sandy clay loam. The middle part is reddish brown, firm clay loam. The lower part is reddish brown, friable sandy clay loam that contains a few sandstone rock fragments. Soft sandstone is at a depth of about 35 inches. In places, the depth to sandstone is more than 40 inches. In some areas where the upper part of the subsoil has been mixed with the surface soil by tillage, the surface layer is brown clay loam.

Included with this soil in mapping and making up 10 to 15 percent of the map unit are small areas of Hedville and Irwin soils. The shallow Hedville soils are on steeper side slopes and narrow ridgetops. The deep Irwin soils have a more clayey subsoil and are on ridgetops above the Lancaster soil.

Permeability in this Lancaster soil is moderate, and runoff is medium. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. Tilth is good. The surface layer is slightly acid. The subsoil has moderate shrink-swell potential. Root development is restricted below a depth of about 35 inches.

Nearly all of the acreage of this soil is used for cultivated crops. This soil is moderately well suited to wheat, grain sorghum, soybeans, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, crop residue management, and minimum tillage help reduce erosion, maintain organic matter content, and good tilth. Leaving crop residue on the surface reduces the runoff rate and improves the rate of water infiltration.

This soil is moderately well suited to local roads and streets and to dwellings. However, low strength is a limitation for local roads and streets, and shrink-swell potential and depth to rock are limitations for dwellings. Roads and streets should be designed so that the surface pavement and base material are thick enough to prevent damage from low strength. Coarse-grained material can be used to prevent damage caused by shrinking and swelling of the soil. For dwellings, properly designing and reinforcing foundations, installing foundation drains, and backfilling with coarse-grained material help prevent structural damage caused by shrinking and swelling of the soil. Depth to rock is a limitation for dwellings with basements, but the rock is generally soft and can be excavated.

This soil is generally unsuited to septic tank absorption fields and is poorly suited to sewage lagoons because of depth to bedrock. Constructing sewage lagoons requires borrowing soil or ripping because of the moderate depth to bedrock. The bottom of the lagoon may need to be sealed to prevent excessive seepage into fractures in the bedrock. Deeper included soils on ridgetops are better suited to sewage lagoons.

The capability subclass of this soil is IIIe, and the range site is Loamy Upland.

Lt—Lancaster loam, 3 to 7 percent slopes. This moderately deep, moderately sloping, well drained soil is on side slopes. A few sandstone rocks, 6 inches to 1 foot in diameter, are on the surface. Individual areas are irregular in shape and range from 40 to 100 acres in size.

Typically, the surface layer is dark grayish brown loam about 7 inches thick. The subsoil is about 28 inches thick. The upper part is brown, friable sandy clay loam. The middle part is reddish brown, very firm clay loam. The lower part is reddish brown, friable sandy clay loam that contains a few sandstone rock fragments. Soft sandstone is at a depth of about 35 inches. In places where the upper part of the subsoil has been mixed with the surface soil by tillage, the surface layer is brown clay loam and contains sandstone fragments. In other places, the depth to sandstone is greater than 40 inches.

Included with this soil in mapping and making up 10 percent of the map unit are small areas of Edalgo and Hedville soils. Edalgo soils have a clayey subsoil and are on similar side slopes. The shallow Hedville soils are on steeper upper side slopes and narrow ridgetops.

Permeability in this Lancaster soil is moderate, and runoff is medium. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. Tilth is good. The surface layer is slightly acid. The subsoil has moderate shrink-swell potential. Root development is restricted below a depth of about 35 inches.

About half of the areas are used for cultivated crops, and the remaining areas are used for range. This soil is moderately well suited to cultivated crops. Wheat, grain sorghum, soybeans, and alfalfa are the main crops grown. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, crop residue management, and minimum tillage help reduce erosion and maintain organic matter content and good tilth. Leaving crop residue on the surface reduces the runoff rate, helps control erosion, and improves the rate of water infiltration.

The soil is suited to range. The predominant native vegetation is big bluestem, little bluestem, switchgrass, and indiangrass. Overused areas are dominated by blue grama, buffalograss, and sideoats grama. Proper stocking rates, deferred grazing, and uniform distribution of livestock help keep the range in good condition. Also, range seeding is needed to restore productivity on abandoned cropland.

This soil is moderately well suited to local roads and streets and to dwellings. However, low strength is a limitation for local roads and streets, and shrink-swell potential and depth to bedrock are limitations for dwelling sites. Roads and streets should be designed so that the surface pavement and base material are thick enough to prevent damage as a result of low strength. Using coarse-grained paving material can be used to prevent damage caused by shrinking and swelling of the soils. For dwellings, properly designing and reinforcing foundations, installing foundation drains, and backfilling with coarse-grained material help prevent structural damage caused by low strength and by shrinking and swelling of the soil. Depth to rock is a limitation for dwellings with basements, but the rock is generally soft and can be excavated.

The soil is generally unsuited to septic tank absorption fields and is poorly suited to sewage lagoons because of depth to bedrock. Constructing sewage lagoons requires borrowing soil or ripping because of the moderate depth to bedrock. The bottom of the lagoon may need to be sealed to prevent excessive seepage into fractures in the bedrock.

The capability subclass of this soil is IVe, and the range site is Loamy Upland.

Lv—Lancaster-Hedville complex, 3 to 20 percent slopes. These moderately deep, well drained Lancaster soils and shallow, somewhat excessively drained Hedville soils are on side slopes and narrow ridgetops. The moderately sloping Lancaster soils are on side

slopes below ridgetop breaks. The strongly sloping Hedville soils are on upper side slopes and narrow ridgetops. Sandstone rocks, 1 foot to 2 feet in diameter, are 5 to 100 feet apart on the surface. Areas of these soils are dissected by deeply entrenched drainageways (fig. 10). Individual areas are irregular in shape and range from 20 to 500 acres in size. About 60 percent of this map unit is Lancaster soils, and about 25 percent is Hedville soils. The areas of these soils are so intricately mixed or so small that it is not practical to separate them at the scale used in mapping.

Typically, the Lancaster soils have a brown loam surface layer about 7 inches thick. The subsoil is about 28 inches thick. The upper part is brown, friable sandy clay loam. The middle part is reddish brown, very firm clay loam. The lower part is reddish brown, firm sandy clay loam that contains a few small fragments of sandstone rock. Soft sandstone bedrock is at a depth of about 35 inches. In some places, the surface layer is stony sandy loam. In places, the depth to bedrock is greater than 40 inches.

Typically, the Hedville soils have a dark grayish brown stony loam surface layer about 10 inches thick. The subsurface layer is brown, very friable loam about 7 inches thick that contains some gravel and cobbles. Sandstone bedrock is at a depth of about 17 inches.

Included with these soils in mapping and making up about 15 percent of the map unit are small areas of Cass and Edalgo soils. The deep Cass soils are along narrow drainageways and are occasionally flooded. The

Figure 10.—Strongly sloping side slopes and deeply entrenched drainageways are typical of this Lancaster-Hedville complex, 3 to 20 percent slopes.

moderately deep Edalgo soils have a clayey subsoil and are on side slopes similar to those of the Lancaster soil.

These Lancaster and Hedville soils have moderate permeability and rapid runoff. Organic matter content is moderate, and natural fertility is medium. Lancaster soils have moderate available water capacity. Hedville soils have very low available water capacity. Root development is restricted below a depth of about 35 inches in the Lancaster soils and about 17 inches in the Hedville soils. The Lancaster subsoil has moderate shrink-swell potential.

These soils are best suited to range, and nearly all of the acreage is used for range. These soils are generally unsuited to cultivation because of the surface stones and the severe hazard of erosion. The native vegetation is predominantly big bluestem, little bluestem, indiangrass, and switchgrass. Overgrazed areas are dominated by less productive grasses, such as blue grama, sideoats grama, and buffalograss. Proper stocking rates and timely deferment of grazing help retain the more desirable grasses. Proper distribution of salting and water facilities encourage an adequate distribution of livestock.

Hedville soils are generally unsuited to building sites because of the shallowness to bedrock.

Lancaster soils are moderately well suited to dwellings and to local roads and streets. For both uses, some land shaping is commonly needed to compensate for slope. Shrink-swell potential is a limitation for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help reduce damage caused by shrinking and swelling of the soil. Depth to bedrock is an additional limitation for dwellings with basements, but the rock is soft and can be easily excavated. Roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for low strength of the soil material.

Lancaster soils are generally unsuited to septic tank absorption fields and poorly suited to sewage lagoons because of depth to bedrock. Constructing sewage lagoons requires borrowing soil or ripping because of the moderate depth to bedrock. Deeper, less sloping soils on lower side slopes are well suited to sewage disposal systems.

The capability subclass of these soils is VIe. The range site for Lancaster soils is Loamy Upland, and the range site for Hedville soils is Shallow Sandstone.

Os—Osage silty clay. This deep, nearly level, poorly drained soil is on flood plains along the major streams. It is in slight depressions. It is occasionally flooded for brief periods. Individual areas are irregular in shape and range from 10 to 80 acres in size.

Typically, the surface layer is very dark gray silty clay about 8 inches thick. The subsurface layer is very dark gray, very firm silty clay about 13 inches thick. The subsoil is about 23 inches thick. The upper part is dark gray, mottled, extremely firm silty clay. The lower part is grayish brown, mottled, extremely firm silty clay. The substratum to a depth of about 60 inches is dark gray, mottled, silty clay that contains some lime concretions. In places, the surface layer and subsoil are calcareous.

Included with this soil in mapping and making up about 10 percent of the map unit are small areas of Reading and Verdigris soils. The well drained and less clayey Reading soils are on higher stream terraces. The moderately well drained and silty Verdigris soils are on flood plains adjacent to stream channels.

Permeability in this Osage soil is very slow, and runoff is very slow. Available water capacity is moderate. The surface layer is firm and has poor tilth. Cracking of the surface layer and subsoil may occur during dry seasons. Natural fertility is medium, and organic matter content is moderate. The seasonal high water table is at a depth of 0 to 1 foot. The surface layer is medium acid. The subsoil has very high shrink-swell potential.

Nearly all of the acreage of this soil is used for cultivated crops. This soil is moderately well suited to wheat, soybeans, and grain sorghum. If cultivated crops are grown, there is a hazard of flood damage. The soil is wet in the spring, but it is droughty in the summer because the clayey subsoil releases water slowly. Installing surface drains or filling depressions helps improve surface drainage. Performing tillage operations when the soil is too wet or too dry causes the soil to be cloddy. Minimum tillage performed at optimum moisture conditions and proper use of crop residue help to maintain tilth, content of organic matter, and fertility.

This soil is generally unsuited to building sites because of flooding. Flooding is difficult to overcome without major flood control measures.

The capability subclass of this soil is IIIw, and the range site is Clay Lowland.

Pt—Pits, quarries. This map unit consists of areas from which soil and underlying material have been excavated. The material removed is mainly limestone rock, but includes shale, chert, and gravel. The exposed areas, which range from 5 to 50 acres in size and have vertical walls 10 to 40 feet deep, are limestone or shale rock and support few or no plants. They are on uplands, mainly in areas of Clime, Kipson, and Sogn soils.

Pits, quarries, is not placed in a capability group or a range site.

Re—Reading silt loam. This deep, nearly level, well drained soil is on stream terraces that rarely flood. Individual areas are irregular in shape and range from 30 to 200 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown, friable silty clay loam about 6 inches thick. The subsoil is brown, firm, silty clay loam about 30

inches thick. The substratum to a depth of about 60 inches is brown silty clay loam. In places, the subsoil is silt loam.

Included with this soil in mapping and making up about 5 to 10 percent of the map unit are small areas of Chase and Wells soils. Chase soils are more clayey and are in slightly lower positions. Wells soils have a reddish brown subsoil and are on adjacent uplands.

Permeability in this Reading soil is moderately slow, and available water capacity is high. Runoff is slow. Tilth is good. Natural fertility is high, and the organic matter content is moderate. The surface layer is slightly acid. The subsoil has moderate shrink-swell potential.

Nearly all of the acreage of this soil is used for cultivated crops. This soil is well suited to wheat, grain sorghum, soybeans, and alfalfa (fig. 11). The main concern of management is maintaining fertility, tilth, and organic matter content. Crop residue management and minimum tillage help maintain fertility, tilth, and organic matter content and conserve moisture.

This soil is generally unsuited to building site development because of flooding. Flooding is difficult to overcome without major flood control measures.

The capability class of this soil is I, and the range site is Loamy Lowland.

Rh—Rosehill silty clay, 1 to 3 percent slopes. This moderately deep, gently sloping, moderately well drained soil is on side slopes. Individual areas of this soil are irregular in shape and range from 20 to 100 acres in size.

Typically, the surface layer is very dark gray silty clay about 8 inches thick. The subsoil is about 20 inches thick. The upper part is dark grayish brown, extremely firm silty clay. The lower part is pale olive, mottled, extremely firm silty clay that contains few fine lime concretions. Shale is at a depth of about 28 inches. In places, the depth to shale is greater than 40 inches. In other places, the subsoil is calcareous.

Included with this soil in mapping and making up about 10 percent of the map unit are small areas of Irwin soils. The Irwin soils, which are on ridgetops, are more than 40 inches deep over shale and have a less clayey surface layer.

Permeability in this Rosehill soil is very slow, and runoff is medium. Available water capacity is low. Natural fertility is medium, and organic matter content is moderate. The surface layer is firm and has poor tilth. The surface layer is slightly acid. Root development is restricted below a depth of about 28 inches. The subsoil has high shrink-swell potential.

Nearly all of the acreage of this soil is used for cultivated crops. This soil is moderately well suited to wheat, grain sorghum, and soybeans. It is less well suited to alfalfa, but this crop is often used in the rotation. If cultivated crops are grown, erosion is a hazard. This soil is droughty in the summer because the clayey subsoil releases water slowly. Terraces, grassed waterways, contour farming, crop residue management, and minimum tillage help reduce erosion and maintain organic matter content and tilth. Leaving crop residue on the surface reduces the runoff rate, helps to control erosion, and improves water infiltration.

Figure 11.—Soybeans growing in an area of Reading silt loam.

This soil is poorly suited to local roads and streets and to dwelling sites. Shrink-swell potential is a limitation for both uses, and low strength is a limitation for roads. Roads and streets should be designed so that the surface pavement and base material are thick enough to prevent damage resulting from shrinking and swelling and from low strength. Coarse-grained base material can

be used to reduce damage caused by shrinking and swelling of the soil. For dwellings, properly designing and reinforcing foundations, installing foundation drains, and backfilling with coarse-grained material help prevent structural damage caused by shrinking and swelling of the soil.

This soil is generally unsuited to septic tank absorption fields because of very slow permeability and depth to rock. It is moderately well suited to sewage lagoons, but depth to rock is a limitation. Constructing sewage lagoons requires borrowing soil or ripping because of the moderate depth to bedrock. The bottom of the lagoon may need to be sealed to prevent excessive seepage into fractures in the bedrock.

The capability subclass of this soil is IIIe, and the range site is Clay Upland.

So—Sogn silty clay loam, 0 to 15 percent slopes. This shallow, nearly level to strongly sloping, somewhat excessively drained soil is on ridgetops and side slopes. In most areas, outcrops of limestone rock are near the ridgetops. Individual areas are irregular in shape and range from 20 to 200 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 8 inches thick. Limestone underlies the surface layer. In places, the surface layer contains platy fragments of limestone. In other places, the surface layer is underlain by shale.

Included with this soil in mapping and making up about 5 percent of the map unit are small areas of Clime and Labette soils and outcrops of limestone rock. Clime soils are underlain by shale at a depth of 20 to 40 inches and are on lower side slopes. The moderately deep Labette soils are on ridgetops. Outcrops of limestone rock are on ridgetops and side slopes.

Permeability in this Sogn soil is moderate, and available water capacity is very low. Runoff is rapid. Natural fertility is low, and the organic matter content is moderate. The surface layer is slightly acid. Root development is restricted below a depth of about 8 inches. The soil has moderate shrink-swell potential.

Nearly all of the acreage of this soil is used for range, and this soil is best suited to this use. This soil is unsuited to cultivated crops because bedrock interferes with tillage. The native vegetation is predominantly sideoats grama, big bluestem, and little bluestem. Prolonged overgrazing causes desirable grasses to decrease and less productive vegetation, such as annual bromegrass and annual broomweed, to increase. Proper stocking rates, uniform distribution of livestock, and deferred grazing help keep the range in good condition. Prescribed burning helps prevent encroachment of brush.

This soil is generally unsuited to building sites because of depth to bedrock. Onsite investigation may reveal areas of included deeper soils on the ridgetops that are suited to buildings, roads, and sanitary facilities.

The capability subclass of this soil is VIIs, and the range site is Shallow Limy.

Tu—Tully silty clay loam, 2 to 6 percent slopes. This deep, moderately sloping, well drained soil is on foot slopes. Individual areas are irregular in shape and range from 30 to several hundred acres in size.

Typically, the surface soil is very dark gray silty clay loam about 17 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown, very firm silty clay. The middle part is brown, very firm silty clay. The lower part is dark brown, firm silty clay that contains a few fine lime concretions. The substratum to a depth of about 60 inches is reddish brown silty clay that contains a few fine lime and black concretions. In places, the surface layer contains some chert fragments. In some areas where the upper part of the subsoil has been mixed with the surface soil by tillage, the surface layer is dark brown silty clay.

Included with this soil in mapping and making up about 5 to 10 percent of the map unit are small areas of Clime and Labette soils. These moderately deep soils are on the upper side slopes.

Permeability in this Tully soil is slow, and available water capacity is high. Runoff is rapid. Natural fertility is high, and the organic matter content is moderate. The surface soil is neutral. Tilth is good. The subsoil has high shrink-swell potential.

About half of the acreage of this soil is used for cultivated crops, and the remaining acreage is used for range. This soil is moderately well suited to wheat, grain sorghum, soybeans, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, returning crop residue to the soil, and minimum tillage help reduce erosion and maintain organic matter content and good tilth.

This soil is suited to range. The native vegetation is predominantly big bluestem, switchgrass, and indiangrass. In overused areas, the range becomes invaded by less desirable plants, such as tall dropseed, Baldwin ironweed, and western ragweed. Proper stocking rates, uniform distribution of livestock, and timely deferment of grazing help keep the range in good condition. Range seeding is needed to restore productivity on abandoned cropland. When used for hay, early mowing allows the native grasses to recover before frost.

In this map unit, many areas of rangeland are adjacent to cropland. Shrub plantings along the cropland-rangeland edge provide needed winter cover for such upland wildlife as pheasant.

The soil is moderately well suited to local roads and streets and to dwelling sites. However, shrink-swell potential is a limitation for both uses. In addition, low strength is a limitation for local roads and streets. Roads and streets should be designed so the surface pavement and base material are thick enough to prevent damage

resulting from shrinking and swelling and from low strength. Coarse-grained base material can be used to reduce damage caused by shrinking and swelling of the soil. For dwellings, properly designing and reinforcing foundations, installing foundation drains, and backfilling with coarse-grained material help prevent structural damage caused by shrinking and swelling of the soil.

This soil is generally unsuited to septic tank absorption fields because of slow permeability. It is moderately well suited to sewage lagoons, but some slope modification is needed for this use.

The capability subclass of this soil is IIIe, and the range site is Loamy Upland.

Vb—Verdigris silt loam. This deep, nearly level, moderately well drained soil is on flood plains along major streams. It is occasionally flooded for very brief periods. Individual areas are long and wide and range from 30 to 200 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 9 inches thick. The next layer is dark grayish brown, friable silt loam about 31 inches thick. The substratum to a depth of about 60 inches is grayish brown silt loam. In places, the surface layer has thin, light colored sandy or silty material deposited from recent floods.

Included with this soil in mapping and making up about 10 percent of the map unit are small areas of Chase soils that are on landscape positions similar to those of the Verdigris soil. Chase soils are more clayey throughout.

Permeability in this Verdigris soil is moderate, and available water capacity is high. Runoff is slow. Natural fertility is high, and organic matter content is moderate. Tilth is good. The surface layer is neutral. The subsoil has moderate shrink-swell potential.

Nearly all of the acreage of this soil is used for cultivated crops. This soil is well suited to wheat, grain sorghum, soybeans, and alfalfa. If it is used for cultivated crops, there is a hazard of flood damage. Terraces and minimum tillage on adjacent uplands help reduce flooding on this soil. Minimum tillage and proper crop residue management help maintain good tilth and increase moisture infiltration.

This soil is generally unsuited to building sites because of flooding. Flooding is difficult to overcome without major flood control measures.

The capability subclass of this soil is IIw, and the range site is Loamy Lowland.

Vc—Verdigris silt loam, channeled. This deep, nearly level, moderately well drained soil is on narrow flood plains that are deeply incised by stream channels (fig. 12). It is frequently flooded. Individual areas are long and narrow and range from 10 to 60 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 8 inches thick. The next layer is dark grayish brown, friable silt loam about 28 inches thick. The substratum to a depth of about 60 inches is grayish brown, friable silt loam. In places, the surface layer contains fragments of shale and limestone. In other places, the substratum is calcareous.

Included with this soil in mapping and making up about 5 to 10 percent of the map unit are small areas of Chase soils. Chase soils are more clayey throughout and are on areas farther from the stream channel.

Permeability in this Verdigris soil is moderate, and available water capacity is high. Runoff is slow. Natural fertility is high, and organic matter content is moderate. The surface layer is neutral. Tilth is good. The subsoil has moderate shrink-swell potential.

Most of the acreage of this soil is used as range. A few small areas are used for cultivated crops. However, this soil is generally unsuited to cultivated crops because of flooding. It is also difficult to use machinery along the meandering stream channel. In places where the range is in good condition, the vegetation is predominantly big bluestem, indiangrass, and eastern gamagrass. Many areas of range are overgrazed and in poor condition because they are near watering facilities and shade trees where cattle congregate. In these areas, the more desirable grasses are replaced by less productive grasses and weeds, such as tall dropseed, buckbrush, and western ragweed. A canopy of eastern cottonwood, green ash, and willow trees is common. Range productivity can be increased by rotational grazing and by restricting grazing to winter months.

The vegetation common to this soil provides habitat for many kinds of wildlife, including quail, deer, wild turkey, rabbit, and numerous songbirds. Wildlife populations can be increased by providing more adjacent areas of forestland-cropland.

This soil is generally unsuited to building sites because of flooding. It is difficult to overcome the limitation of flooding without the use of major control measures.

The capability subclass of this soil is Vw, and the range site is Loamy Lowland.

Wb—Wells loam, 1 to 3 percent slopes. This deep, gently sloping, well drained soil is on side slopes, mounds, and ridgetops. Individual areas are irregular in shape and range from 20 to 80 acres in size.

Typically, the surface layer is dark brown loam about 9 inches thick. The subsoil is about 27 inches thick. The upper part is dark reddish gray, friable loam. The lower part is reddish brown, firm sandy clay loam. The substratum to a depth of about 60 inches is reddish brown sandy loam. In places, the surface layer is loamy fine sand. In other places, the surface layer is silt loam or silty clay loam.

Included with this soil in mapping, and making up about 10 percent of the map unit, are small areas of Clime and Irwin soils. The moderately deep, calcareous

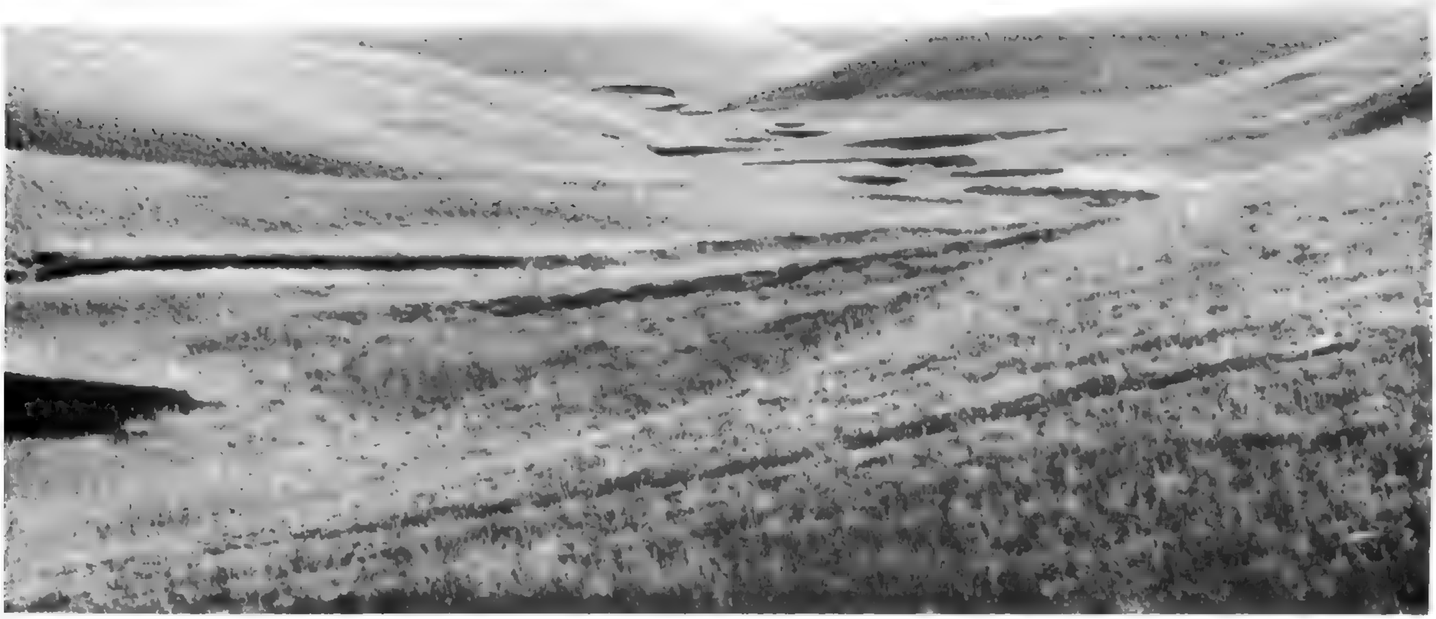

Figure 12.—An area of Verdigris silt loam, channeled, in native grass. The soil on the uplands is Florence silty clay loam.

Clime soils and the deep, more clayey Irwin soils are on higher ridgetops.

Permeability in this Wells soil is moderate, and runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. Tilth is good. The surface layer is slightly acid. The subsoil has moderate shrink-swell potential.

Nearly all of the acreage of this soil is used for cultivated crops. This soil is well suited to wheat, grain sorghum, soybeans, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, returning crop residue to the soil, and minimum tillage help reduce erosion and maintain organic matter content and good tilth.

This soil is well suited to dwellings; however, shrinking and swelling of the soil can be a limitation. Foundations and footings should be properly designed to prevent structural damage caused by shrinking and swelling of the soil. The soil is moderately well suited to roads and streets. Roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for the low strength of the soil material. Coarse-grained base material can be used to reduce damage caused by shrinking and swelling of the soil.

This soil is well suited to septic tank absorption fields. It is moderately well suited to sewage lagoons. Seepage can be a limitation for sewage lagoons. Sealing the lagoon helps reduce seepage. If less sloping areas are selected, construction requires less leveling and banking.

The capability subclass of this soil is IIe, and the range site is Loamy Upland.

Wc—Wells loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is on side slopes near drainageways. Individual areas are irregular in shape and range from 40 to 150 acres in size.

Typically, the surface layer is dark brown loam about 7 inches thick. The subsoil is about 27 inches thick. The upper part is dark reddish gray, friable loam, and the lower part is reddish brown, firm sandy clay loam. The substratum to a depth of about 60 inches is reddish brown sandy loam. In other places, the surface layer and subsoil are more silty. In some areas, where the upper part of the subsoil has been mixed with the surface soil by tillage, the surface layer is reddish brown clay loam.

Included with this soil in mapping and making up about 10 percent of the map unit are small areas of Clime and Irwin soils. The calcareous Clime soils are moderately deep over shale and are on the steeper side slopes. The deep, more clayey Irwin soils are near the ridgetops.

Permeability in this Wells soil is moderate, and runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. Tilth is good. The surface layer is slightly acid. The subsoil has moderate shrink-swell potential.

Nearly all of the acreage of this soil is used for cultivated crops. This soil is moderately well suited to wheat, grain sorghum, and alfalfa. If cultivated crops are grown, erosion is a hazard. Terraces, grassed waterways, contour farming, and minimum tillage help reduce excessive soil loss. Leaving crop residue on the surface helps maintain organic matter content and tilth.

This soil is well suited to dwellings; however, shrinking and swelling of the soil can be a limitation. Foundations and footings should be properly designed to prevent structural damage caused by shrinking and swelling of the soil. The soil is moderately well suited to roads and streets. Roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for low strength of the soil material. Coarse-grained base material can be used to reduce damage caused by shrinking and swelling of the soil.

This soil is well suited to septic tank absorption fields. It is moderately well suited to sewage lagoons. Seepage can be a limitation for sewage lagoons. Sealing the lagoons helps reduce seepage. If less sloping areas are selected, construction requires less leveling and banking.

The capability subclass of this soil is IIIe, and the range site is Loamy Upland.

Wd—Wells clay loam, 3 to 7 percent slopes, eroded. This deep, moderately sloping, well drained soil is on side slopes of uplands. Individual areas are irregular in shape and range from 40 to 200 acres in size.

Typically, the surface layer is dark brown clay loam about 9 inches thick. The subsoil is about 27 inches thick. The upper part is brown, firm clay loam. The lower part is reddish brown, firm sandy clay loam. The substratum to a depth of about 60 inches is reddish brown sandy loam. In places where the upper part of the subsoil has been mixed with the surface soil by tillage the surface layer is brown or reddish brown. In other places, the surface layer and subsoil are more silty.

Included with this soil in mapping and making up about 10 to 15 percent of the map unit are small areas of Irwin and Lancaster soils. The more clayey Irwin soils are on ridgetops at higher elevations. The moderately deep Lancaster soils are on upper side slopes.

Permeability in this Wells soil is moderate, and runoff is rapid. Available water capacity is high. Natural fertility is medium, and organic matter content is moderately low. Tilth is fair. The surface layer is slightly acid. The subsoil has moderate shrink-swell potential.

This soil is moderately well suited to cultivated crops, and nearly all of its acreage is used for cultivated crops. Wheat, grain sorghum, and alfalfa are the main crops grown. If cultivated crops are grown, further erosion is a hazard. Terraces, grassed waterways, contour farming, and minimum tillage help reduce excessive soil loss. Returning crop residue to the soil helps to maintain organic matter content and improve tilth.

This soil is well suited to dwellings; however, shrinking and swelling of the soil can be a limitation. Foundations and footings should be properly designed to prevent structural damage caused by shrinking and swelling of the soil. The soil is moderately well suited to roads and streets. Roads and streets should be designed so that the surface pavement and base material are thick enough to compensate for low strength of the soil material. Coarse-grained base material can be used to reduce damage caused by shrinking and swelling of the soil.

This soil is well suited to septic tank absorption fields. It is moderately well suited to sewage lagoons. Seepage can be a limitation for sewage lagoons. Sealing the lagoon helps reduce seepage. If less sloping areas are selected, construction requires less leveling and banking.

The capability subclass of this soil is IVe, and the range site is Loamy Upland.

Prime Farmland

Prime farmland is one of several kinds of important farmlands defined by the U.S. Department of Agriculture. It is of major importance in providing the nation's short- and long-range needs for food and fiber. The supply of high quality farmland is limited, and the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, must encourage and facilitate the use of our nation's prime farmland with wisdom and foresight.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season, and moisture supply needed to economically produce a sustained high yield of crops when it is treated and managed using acceptable farming methods. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland may now be in crops, pasture, woodland, or other land, but not urban and built-up land or water areas. It must either be used for producing food or fiber or be available for these uses.

Prime farmland usually has an adequate and dependable supply of moisture from precipitation or irrigation. It also has favorable temperature and growing season as well as acceptable acidity or alkalinity. It has few or no rocks and is permeable to water and air. Prime farmland is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 7 percent. For more detailed information on the criteria for prime farmland, consult the local staff of the Soil Conservation Service.

About 465,000 acres, or 76 percent of Marion County, meets the soil requirements for prime farmland. Areas are scattered throughout the county, but most areas are in the western two-thirds mainly in associations 1, 3, 4, 5, and 7 of the general soil map. Approximately 340,000 acres of this prime farmland is used for crops. Crops grown are mainly wheat, grain sorghum, soybeans, and alfalfa.

Soil map units that make up prime farmland in Marion County are listed in this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps in the back of this publication. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units."

Soils that have limitations—a high water table, flooding, or inadequate rainfall—may qualify for prime farmland if these limitations are overcome by such measures as drainage, flood control, or irrigation. In the following list, the measures used to overcome the limitations, if any, are shown in parentheses after the map unit name. Onsite evaluation is necessary to determine if these limitations have been overcome by corrective measures.

The map units that meet the soil requirements for prime farmland are:

Ca Cass fine sandy loam
Ch Chase silty clay loam
Cm Clime silty clay loam, 1 to 3 percent slopes
Go Goessel silty clay
Ib Irwin silty clay loam, 1 to 3 percent slopes
Ic Irwin silty clay loam, 3 to 6 percent slopes
La Labette silty clay loam, 1 to 4 percent slopes
Lm Ladysmith silty clay loam, 0 to 2 percent slopes
Ls Lancaster loam, 1 to 3 percent slopes
Lt Lancaster loam, 3 to 7 percent slopes
Os Osage silty clay (where drained)
Re Reading silt loam
Rh Rosehill silty clay, 1 to 3 percent slopes
Tu Tully silty clay loam, 2 to 6 percent slopes
Vb Verdigris silt loam
Wb Wells loam, 1 to 3 percent slopes
Wc Wells loam, 3 to 7 percent slopes
Wd Wells clay loam, 3 to 7 percent slopes, eroded

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

John C. Dark, soil conservation agronomist, Soil Conservation Service, assisted in preparing this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Approximately 60 percent of Marion County is used for cultivated crops. During the last 10 years, about 40 percent of the cropland has been used for wheat, 31 percent for sorghum, 7 percent for alfalfa; and 22 percent for corn, soybeans, barley, oats, and other crops (*4*). The acreage in soybeans and wheat has increased; that in all other crops has decreased or remained constant. Approximately 2,500 acres is irrigated.

Soil erosion is the main hazard to cropland in Marion County in areas where the slope exceeds 1 percent. Erosion reduces the soil's productivity by removing organic matter and most of the available plant nutrients. Loss of the surface layer weakens the soil's structure and its rate of water infiltration, and reduces the available moisture capacity and general tilth. Erosion is especially damaging to soils that have a clayey subsoil, such as Irwin and Labette soils. Preparing a good seedbed and tilling are difficult in the clayey spots that remain after the original friable surface layer has eroded away. In many areas soil erosion on farmland also results in the pollution of streams by sediment, nutrients. and pesticides. Controlling erosion minimizes such pollution and improves the quality of water.

Erosion control practices provide a protective surface cover, which reduces runoff and increases water infiltration. A cropping system that keeps plant cover on the soil for extended periods reduces soil erosion and preserves the productive capacity of the soils.

Minimum tillage, terraces, diversions, contouring, and cropping systems that include close-growing crops and row crops help control erosion on cropland. Use of minimum tillage for sorghum and other row crops is increasing in Marion County. This tillage method effectively reduces erosion on sloping soils and can be used on most soils in the survey area.

Most of the arable soils in the county respond well to nitrate and phosphate fertilizers. On all soils, the amount of lime and fertilizer used should be based on the results

Figure 13.—An area of Wells loam, 1 to 3 percent slopes. Bromegrass, used for hay, is in the waterway, and grain sorghum is in the adjoining field.

of soil tests, on the needs of the crop, on farmer experience, and on the expected yield. The Cooperative Extension Service can help to determine the kind and amount of fertilizer and lime to apply.

Organic matter is an important source of nitrogen for crops. Adding organic matter and leaving crop residue on the surface of the soil help increase the water intake rate, reduce surface crusting, reduce soil losses from erosion, and promote good tilth. Most of the soils in the survey area that are used for crops have a surface layer of silty clay loam, silt loam, or loam. Intensive rainfall causes the surface of these soils to crust; the crusted surface is hard and nearly impervious to water when dry. Because of the hard surface, runoff increases. Adding organic matter on a regular basis helps improve soil structure and reduce crust formation. Leaving crop residue on the surface also helps to prevent crust formation.

Terraces and diversions reduce the length of slopes, thereby reducing runoff and erosion. They are most practical on deep, well drained soils that have uniform, regular slopes. Most of the soils in the county have these characteristics. Grassed waterways are used with terrace systems to remove surface water (fig. 13).

Soil drainage is needed on some soils that are not well drained. Unless drained by surface drains or bedding, some areas of Chase, Goessel, Ladysmith, and Osage soils are so wet that crop yields are reduced.

The main concerns in managing the soils for pasture grasses are to maintain or improve the quality and quantity of forage, provide soil protection, and reduce water loss. Some management practices needed to maintain a good stand of tame grasses are proper stocking rate, rotational grazing, scattered water and salt locations, fertilizing, and controlling unwanted vegetation. The main pasture grasses grown in Marion County are smooth bromegrass and tall fescue.

Information on erosion control and drainage practices for each kind of soil can be obtained at the local office of the Soil Conservation Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be

higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; crop rotations and other methods to control weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Rangeland

Leonard J. Jurgens, range conservationist, Soil Conservation Service, assisted in preparing this section.

Approximately 192,000 acres in Marion County is used for rangeland. This acreage represents about 32 percent of the total land area in the county. Most of this rangeland is in the eastern third of the county. A sizable acreage of rangeland is in the northwest part of the county, which is part of the Central Kansas Sandstone Hills Land Resource Area. Small tracts of rangeland are scattered throughout the rest of the county. Native hayland and pastureland are used in conjunction with grazing programs on rangeland.

Cow-calf operations are the major livestock enterprise on these rangelands. A significant number of yearling operations are present, as well as a large number of

stocker-feeder programs that are concentrated primarily in the cropland areas of the county.

Nearly all of the soils in the county have excellent potential for producing high quality forage plants for grazing animals and rangeland wildlife if properly managed. Marion County's unique combination of soils, climate, and topography makes excellent rangeland condition an attainable goal. On most rangeland in the county, the use of proper grazing management practices can restore or maintain the natural plant community near its potential.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for each soil, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as rangeland or are suited to use as rangeland are listed. Explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre of air-dry vegetation. Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, reduction of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Currently, about 20 percent of the rangeland in the county is producing near its potential. About 4,500 acres of the rangeland is abandoned cropland that needs revegetation to restore the natural plant community. Approximately 14,000 acres of the rangeland needs brush control management that allows the natural plant community to express its potential. The remaining rangeland can be restored to its potential by use of grazing management practices.

Native Woodlands, Windbreaks, and Environmental Plantings

Keith A. Ticknor, forester, Soil Conservation Service, assisted in preparing this section.

Native wooded areas in Marion County are along the rivers and streams and in upland drainageways. Approximately 15,300 acres of the county is forested.

Most of the trees in upland drainageways and small streams are eastern cottonwood and black willow. Black walnut, green ash, and hackberry are found in larger numbers within the Verdigris-Chase-Reading soil association along the Cottonwood River. Other common trees in the county are American elm, red elm, bur oak, boxelder, Kentucky coffeetree, Russian mulberry, silver maple, honeylocust, and osageorange.

Several species of trees, especially black walnut, green ash, hackberry, and eastern cottonwood, have

commercial potential. The trees of lower quality are valuable for firewood.

Woodland acreage in Marion County has steadily declined during recent years, mostly because woodland has been cleared and converted to cropland. Only a small part of the woodland in the county is managed for commercial wood production. Most of the wooded areas are privately owned and make up only a small acreage of the farm unit.

Most farmsteads in Marion County have trees around them that serve as windbreaks or environmental plantings. Some of these trees were present when the farmstead was built, but many have been planted at various times by the landowners. Siberian elm and eastern redcedar are the most common trees around the farmstead, especially the older plantings. Other common tree and shrub species are black locust, green ash, lilac, Russian mulberry, honeylocust, and Russian-olive.

Tree planting is a continual process because trees grow old, pass maturity, and deteriorate. Some trees are lost to insect and disease attacks, and others are destroyed by storms. New plantings are needed for new homes or expanding farmsteads. Windbreaks are especially important in reducing energy requirements.

Most field windbreaks or shelterbelts in Marion County are in the form of hedgerows, lining farm and field boundaries. Only a few eight- to ten-row shelterbelts can be found, mostly in the western part of the county. In these shelterbelts are planted eastern redcedar, black walnut, Kentucky coffeetree, American elm, hackberry, honeylocust, Siberian elm, Russian mulberry, osageorange, and fragrant sumac.

In order for windbreaks or environmental plants to fulfill their intended purpose, the species of trees or shrubs selected must be suited to the soils in which they are to be planted. A proper match of trees and soil types is the first step toward insuring seedling survival and a maximum growth rate. Permeability, available water capacity, and fertility are soil characteristics that greatly affect the rate at which trees and shrubs grow.

Trees and shrubs are easy to establish on most sites and soil types in Marion County. Weed and grass competition is the greatest threat to successful windbreak or environmental plantings; therefore, preparing the site properly before planting and controlling weeds and other competition after planting are the main concerns in establishing and caring for trees and shrubs.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

Recreation

Robert J. Higgins, biologist, Soil Conservation Service, assisted in preparing this section.

Marion Reservoir, Marion State Park, and Marion County Lake attract large numbers of visitors during the summer months and especially on weekends. Bird watchers and wildlife photographers use the reservoir throughout the year to observe and photograph migrating waterfowl. Good fishing draws large numbers of people from surrounding counties. Public use facilities are available for camping, fishing, boating, picnicking, and swimming.

Numerous farm ponds and the Cottonwood River and its tributaries provide water recreation on privately owned lands.

Several areas of scenic, geologic, and historic interest are present in Marion County.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to potable water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent or to support sewage lagoons and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Robert J. Higgins, biologist, Soil Conservation Service, assisted in preparing this section.

The most important game species in Marion County are bobwhite quail, prairie chicken, pheasant, mourning dove, cottontail rabbit, white-tailed deer, and several species of waterfowl. Most upland game bird hunting takes place on privately owned land with the permission of the landowner. Duck and goose hunting is usually good at Marion Reservoir and on farmponds during the open season. Bird watchers and wildlife observers frequently use the Marion Reservoir area.

Marion County's many diverse habitat types support a number of nongame species of wildlife. Cropland, woodland, and grassland are intermixed throughout the county, creating the desirable "edge" effect that attracts a wide variety of wildlife. Each habitat type provides a home for a particular group of species.

Furbearers are common along the streams and around the reservoir. Trapping and hunting coyote, raccoon, muskrat, and beaver are enjoyable pastimes for some residents of Marion County.

Stockwater ponds, streams, Marion Reservoir, and Marion County Lake provide good to excellent fishing throughout most of the year. Species commonly caught are largemouth bass, bluegill, channel cat, bullhead, and flathead catfish. In addition to these species, crappie, walleye, white bass, and striped bass are caught at the reservoir.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, grain sorghum, oats, and soybeans.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are the bluestems, gramas, western wheatgrass, switchgrass, sunflowers, ragweeds, goldenrod, and native legumes.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, hackberry, elm, cottonwood, mulberry, black walnut, and ash. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, plum, fragrant sumac, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are red cedar, pine, spruce, and juniper.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of native shrubs are plum, gooseberry, dogwood, buckbrush, prairie rose, and sumac.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattails, saltgrass, prairie cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, and cottontail rabbit.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, owls, hawks, thrushes, woodpeckers, squirrels, opossum, raccoon, and white-tailed deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, redwinged blackbirds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include jack rabbit, badger, prairie chicken, deer, meadowlark, and kill deer.

Developing habitat for wildlife requires proper location of the plant cover most attractive to wildlife on suitable soils. Technical assistance in planning wildlife developments and in determining suitable vegetation for plantings can be obtained from the local office of the Soil Conservation Service. Additional information and assistance can be obtained from the Kansas Fish and Game Commission and from the Cooperative Extension Service.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and

construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Sanitary Facilities

Table 11 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features

are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated

good, fair, or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 foot to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or

minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 17.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69.

The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs, on the average, no more than once in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months;

November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. Only saturated zones within a depth of about 6 feet are indicated. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil Series and Their Morphology." The soil samples were tested by the Kansas Department of Transportation.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*7*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustoll (*Ust*, meaning intermittent dryness, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiustolls (*Argi*, meaning argillic horizon, plus *ustoll*, the suborder of the Mollisols that have a ustic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Pachic* identifies the subgroup that has a thicker surface layer than is typical for the great group. An example is Pachic Argiustolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, mixed, mesic Pachic Argiustolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*6*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*7*). Unless otherwise stated, matrix colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Cass Series

The Cass series consists of deep, well drained, moderately rapidly permeable soils on flood plains. These soils formed in mixed sandy or loamy alluvium. Slope ranges from 0 to 1 percent.

Cass soils are commonly adjacent to Wells, Lancaster, and Verdigris soils. Wells and Lancaster soils are on adjacent uplands. Wells soils have more clay in the solum. Lancaster soils are underlain by sandstone at a depth of 20 to 40 inches. Verdigris soils are on similar flood plains and have less sand in the subsoil.

Typical pedon of Cass fine sandy loam, 2,140 feet north and 250 feet east of the southwest corner of sec. 21, T. 17 S., R. 1 E.

A—0 to 18 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.

AC—18 to 33 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; weak fine granular structure; slightly hard, friable; many fine roots; neutral; gradual smooth boundary.

C—33 to 60 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; massive; slightly hard, very friable; few fine roots; few sandstone pebbles; neutral.

The thickness of the solum ranges from 10 to 35 inches. The mollic epipedon is 10 to 20 inches thick.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly fine sandy loam, but the range includes silt loam and very fine sandy loam. It ranges from medium acid to neutral.

The AC horizon is fine sandy loam, but some pedons have thin strata of loamy fine sand or sandy clay loam.

The C horizon has hue of 10YR, value of 5 to 7 (4 or 5 moist), and chroma of 2 or 3. It is fine sandy loam or loamy fine sand. It ranges from slightly acid to mildly alkaline. Some pedons have strata of loam. Also, in some pedons strata of lime are below a depth of 30 inches.

Chase Series

The Chase series consists of deep, somewhat poorly drained, slowly permeable soils on low stream terraces. These soils formed in clayey alluvium. Slope ranges from 0 to 1 percent.

Chase soils are similar to Osage soils and are commonly adjacent to Reading and Verdigris soils. The poorly drained Osage soils have a more clayey surface layer. Reading soils have a less clayey subsoil and are on higher stream terraces. Verdigris soils do not have an argillic horizon and have a less clayey subsoil. They generally are on flood plains nearer the channel.

Typical pedon of Chase silty clay loam, 2,500 feet south and 1,500 feet east of the northwest corner of sec. 2, T. 21 S., R. 5 E.

Ap—0 to 12 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate fine granular structure; hard, friable; few fine roots; medium acid; gradual smooth boundary.

BA—12 to 20 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; strong fine subangular blocky structure; hard, firm; few fine roots; few wormcasts; slightly acid; gradual smooth boundary.

Bt1—20 to 32 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; strong fine and medium blocky structure; very hard, very firm; thin continuous clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt2—32 to 42 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; common fine faint yellowish brown (10YR 5/8) mottles; moderate medium blocky structure; very hard, very firm; thick patchy clay films on faces of peds; neutral; diffuse smooth boundary.

BC—42 to 60 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; common medium distinct strong brown (7.5YR 5/6) mottles; weak fine blocky structure; very hard, very firm; neutral.

The thickness of the solum ranges from 36 to 60 inches. The mollic epipedon is more than 36 inches thick. The solum ranges from medium acid to neutral. In some pedons, fine lime concretions are below 36 inches.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam.

The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6 (2 to 5 moist), and chroma of 1 or 2. It is silty clay loam or silty clay.

Some pedons have a C horizon.

Clime Series

The Clime series consists of moderately deep, well drained, slowly permeable soils on uplands. These soils formed in residuum of calcareous, clayey shale. Slope ranges from 1 to 30 percent.

Clime soils are similar to Kipson and Rosehill soils and are commonly adjacent to Irwin, Labette, and Sogn soils. Kipson soils are less than 20 inches deep over shale. Rosehill soils do not have lime in the solum. Irwin soils have an argillic horizon and are more than 40 inches deep over bedrock. Labette soils have an argillic horizon. Irwin and Labette soils are on divides above Clime soils. Sogn soils are less than 20 inches deep over limestone and are on less sloping areas above Clime soils.

Typical pedon of Clime silty clay loam, 1 to 3 percent slopes, 2,540 feet east and 200 feet north of the southwest corner of sec. 3, T. 19 S., R. 3 E.

Ap—0 to 10 inches; very dark gray (10YR 3/1) silty clay loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; few fine roots; slight effervescence; moderately alkaline; clear smooth boundary.

Bw—10 to 23 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; strong fine

subangular blocky structure; hard, firm; few fine roots; few shale fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

C—23 to 30 inches; pale yellow (2.5Y 7/4) silty clay, light olive brown (2.5Y 5/4) moist; massive; very hard, very firm; 15 percent shale fragments; strong effervescence; moderately alkaline; diffuse smooth boundary.

Cr—30 inches; light brownish gray (2.5Y 6/2) calcareous shale.

The thickness of the solum ranges from 13 to 25 inches. Depth to calcareous shale ranges from 20 to 40 inches. The soil is mildly alkaline or moderately alkaline throughout. Some pedons do not have lime in the upper 10 inches.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes stony silty clay loam and silty clay.

The Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 1 to 4. It is silty clay or silty clay loam.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is silty clay loam and silty clay.

Dwight Series

The Dwight series consists of deep, moderately well drained, very slowly permeable sodic soils on uplands. These soils formed in clayey sediments. Slope ranges from 0 to 3 percent.

Dwight soils are commonly adjacent to Irwin, Labette, and Sogn soils. These soils do not have a natric horizon, and they are on landscape positions similar to those of the Dwight soils. Labette soils are underlain by limestone at a depth of 20 to 40 inches, and Sogn soils are underlain by limestone at a depth of less than 20 inches.

Typical pedon of Dwight silt loam, 0 to 2 percent slopes, 1,500 feet west and 1,420 feet south of the northeast corner of sec. 14, T. 22 S., R. 5 E.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, friable; slightly acid; many fine roots; abrupt smooth boundary.

Btn1—6 to 16 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium columnar structure parting to moderate medium blocky; very hard, very firm; many fine roots; thick continuous clay films on faces of peds; slightly acid; clear smooth boundary.

Btn2—16 to 23 inches; brown (7.5YR 5/2) silty clay, dark brown (7.5YR 3/2) moist; strong medium blocky structure; extremely hard, extremely firm; few fine roots; thin continuous clay films on faces of peds; mildly alkaline; gradual smooth boundary.

BCn—23 to 37 inches; brown (7.5YR 5/4) silty clay, dark brown (7.5YR 4/4) moist; weak coarse blocky structure; very hard, very firm; few fine roots; thin patchy clay films on faces of peds; few fine lime concretions; mildly alkaline; clear smooth boundary.

C—37 to 56 inches; brown (7.5YR 5/4) silty clay, brown (7.5YR 4/4) moist; common medium distinct dark gray (10YR 4/1) and strong brown (7.5YR 5/6) mottles; massive; very hard, very firm; mildly alkaline; abrupt smooth boundary.

2R—56 inches; hard limestone.

The thickness of the solum ranges from 30 to 55 inches. Depth to limestone ranges from 40 to 60 inches. The mollic epipedon is 15 to 30 inches thick.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silt loam, but the range includes silty clay loam. Reaction ranges from medium acid to neutral.

The Btn horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 to 4 moist), and chroma of 1 to 3. It is clay or silty clay. Reaction ranges from slightly acid to moderately alkaline and the horizon has from 10 to 15 percent exchangeable sodium.

The BCn horizon has 15 to 20 percent exchangeable sodium.

The C horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 or 4. It is silty clay or silty clay loam. It ranges from neutral to moderately alkaline.

Edalgo Series

The Edalgo series consists of moderately deep, well drained, very slowly permeable soils on uplands. These soils formed in residuum of clayey shale. Slope ranges from 3 to 12 percent.

Edalgo soils are similar to Labette soils and are commonly adjacent to Hedville and Lancaster soils. Labette soils have limestone bedrock within a depth of 40 inches and are on less sloping ridgetops. Hedville soils are less than 20 inches deep over sandstone and are on steeper upper side slopes and narrow ridgetops. Lancaster soils have a less clayey subsoil and are underlain by sandstone at a depth of 20 to 40 inches. They are on landscape positions similar to those of Edalgo soils.

Typical pedon of Edalgo silty clay loam, 3 to 12 percent slopes, 2,440 feet south and 200 feet east of the northwest corner of sec. 20, T. 18 S., R. 1 E.

A—0 to 10 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, friable; many fine roots; medium acid; clear smooth boundary.

Bt1—10 to 14 inches; brown (10YR 5/3) silty clay, brown (10YR 4/3) moist; weak fine subangular blocky

structure; hard, firm; many fine roots; medium acid; gradual smooth boundary.

Bt2—14 to 24 inches; brown (10YR 5/3) silty clay, brown (10YR 4/3) moist; few fine faint strong brown (7.5YR 5/6) mottles; moderate fine blocky structure; very hard, very firm; few fine roots; slightly acid; gradual smooth boundary.

C—24 to 34 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; common coarse distinct yellowish brown (10YR 5/8) mottles; massive; extremely hard, extremely firm; few fine roots; neutral; gradual irregular boundary.

Cr—34 inches; light brownish gray (2.5Y 6/2) shale.

The thickness of the solum ranges from 20 to 36 inches. Depth to shale bedrock ranges from 20 to 40 inches. The mollic epipedon is 8 to 18 inches thick. The solum ranges from medium acid to neutral. Some pedons have lime concretions in the C horizon.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is silty clay loam or silt loam.

The Bt horizon has hue of 10YR or 7.5YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 to 4. It is silty clay or silty clay loam.

The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 1 to 4. It is silty clay or clay.

Florence Series

The Florence series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in residuum of cherty limestone (fig. 14). Slope ranges from 2 to 15 percent.

Florence soils are commonly adjacent to Dwight, Labette, and Tully soils. Dwight soils have a thin A horizon and sodium in the lower part of the subsoil and are on ridgetops. Labette soils are underlain by limestone at a depth of 20 to 40 inches and are on ridgetops. Tully soils have a thicker mollic epipedon and are on foot slopes.

Typical pedon of Florence silt loam, 2 to 15 percent slopes, 1,250 feet south and 15 feet west of the northeast corner of sec. 26, T. 20 S., R. 5 E.

A—0 to 13 inches; very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; strong fine and medium granular structure; slightly hard, friable; many fine roots; few fine angular chert fragments; slightly acid; gradual smooth boundary.

BA—13 to 16 inches; dark brown (7.5YR 3/2) cherty silty clay loam, dark reddish brown (5YR 2/2) moist; moderate medium and fine blocky structure; very hard, very firm; many fine roots; 15 percent angular chert fragments 1/2 inch to 3 inches in diameter; slightly acid; gradual irregular boundary.

Figure 14.—Florence soils contain many chert fragments. Depth is shown in feet.

Bt—16 to 45 inches; reddish brown (5YR 4/4) extremely cherty clay, dark reddish brown (5YR 3/4) moist; moderate medium and fine blocky structure; extremely hard, very firm; 80 percent angular chert fragments 1/2 inch to 3 inches in diameter; mildly alkaline; clear irregular boundary.

R—45 inches; cherty limestone.

The thickness of the solum and depth to cherty limestone range from 40 to 60 inches. The mollic epipedon is 10 to 20 inches thick.

The A horizon has hue of 10YR or 7.5YR, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silt loam, but the range includes silty clay loam and cherty silty clay loam. It ranges from medium acid to neutral.

The Bt horizon has hue of 7.5YR, 5YR, or 2.5YR, value of 3 to 5 (3 or 4 moist), and chroma of 3 to 6. Reaction ranges from slightly acid to mildly alkaline. The content of chert ranges from 50 to 85 percent. Some pedons have mottles.

Goessel Series

The Goessel series consists of deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in clayey old alluvium. Slope ranges from 0 to 2 percent.

Goessel soils are similar to Ladysmith soils and are commonly adjacent to Ladysmith, Rosehill, and Wells soils. Ladysmith soils have a less clayey surface layer and are slightly higher on the landscape. Rosehill soils are underlain by shale at a depth of 20 to 40 inches and are on more sloping areas. Wells soils have a loamy subsoil and are on higher, convex slopes.

Typical pedon of Goessel silty clay, 1,700 feet south and 150 feet east of the northwest corner of sec. 6, T. 21 S., R. 1 E.

Ap—0 to 6 inches; very dark gray (10YR 3/1) silty clay, very dark gray (10YR 3/1) moist; moderate fine granular structure; very hard, very firm; few fine roots; few sand grains; neutral; gradual smooth boundary.

A—6 to 13 inches; very dark gray (10YR 3/1) silty clay, very dark gray (10YR 3/1) moist; moderate fine granular structure; very hard, very firm; few fine roots; few sand grains; neutral; gradual smooth boundary.

AC1—13 to 20 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate fine blocky structure; extremely hard, firm; common medium slickensides inclined at a 30 degree angle from horizontal; few sand grains; mildly alkaline; gradual smooth boundary.

AC2—20 to 30 inches; gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; few medium distinct olive brown (2.5Y 4/4) mottles and few fine faint light brownish gray (2.5Y 6/2) mottles; moderate fine blocky structure; extremely hard, extremely firm; few sand grains; moderately alkaline; gradual smooth boundary.

AC3—30 to 42 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; common medium distinct strong brown (7.5YR 5/8) mottles and few fine faint light brownish gray (2.5Y 6/2) mottles; weak medium blocky structure; extremely hard, very firm; moderately alkaline; gradual smooth boundary.

C—42 to 60 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; common coarse distinct strong brown (7.5YR 5/6) mottles and few fine distinct light yellowish brown (2.5Y 6/4) mottles; massive; extremely hard, very firm; few fine lime concretions; many coarse sand grains; moderately alkaline.

The thickness of the solum ranges from 40 to 60 inches.

The A horizon has hue of 10YR, value of 3 or 4 (2 or 3 moist), and chroma of 1. It is silty clay loam or silty clay. It is slightly acid or neutral.

The AC horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 to 4 moist), and chroma of 1 or 2. It is silty clay or clay.

The C horizon has hue of 10YR or 2.5Y, value of 3 to 6 (2 to 5 moist), and chroma of 1 to 4. It is clay, silty clay, silty clay loam, or clay loam.

Hedville Series

The Hedville series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in residuum of noncalcareous sandstone. Slope ranges from 3 to 20 percent.

Hedville soils are similar to Sogn soils and are commonly adjacent to Edalgo, Kipson, and Lancaster soils. Sogn soils contain less sand than Hedville soils and are shallow over limestone. Edalgo soils have a clayey subsoil and are on similar side slopes. Kipson soils formed in residuum of calcareous shales and have lime throughout. They are on similar narrow ridgetops and steep side slopes. Lancaster soils are 20 to 40 inches deep over sandstone or sandy shale and are on less sloping side slopes.

Typical pedon of Hedville stony loam, in an area of Lancaster-Hedville complex, 3 to 20 percent slopes, 1,000 feet east and 25 feet north of the southwest corner of sec. 3, T. 17 S., R. 1 E.

A1—0 to 10 inches; dark grayish brown (10YR 4/2) stony loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; many fine roots; 15 percent weathered sandstone fragments less than 3 inches in diameter; slightly acid; gradual clear boundary.

A2—10 to 17 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak fine granular structure; slightly hard, very friable; few small pebbles and cobblestones of weathered sandstone comprise less than 20 percent of soil mass; medium acid; clear irregular boundary.

R—17 inches; very dark grayish brown (10YR 3/2) and brown (10YR 5/3) sandstone.

The thickness of the solum ranges from 4 to 20 inches and is commonly the same as the depth to sandstone. The mollic epipedon is 4 to 18 inches thick. Reaction ranges from medium acid to neutral.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is stony loam, loam, stony sandy loam, or sandy loam. Some pedons have a B or C horizon that has properties similar to the A horizon.

Irwin Series

The Irwin series consists of deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in old alluvium. Slope ranges from 1 to 6 percent.

Irwin soils are similar to Tully soils and are commonly adjacent to Clime, Dwight, Labette, and Ladysmith soils. Tully soils are well drained, have a thicker surface soil, and are on foot slopes. Clime soils are 20 to 40 inches deep over shale and are calcareous throughout. They are on steeper side slopes. Dwight soils have a natric horizon and are on nearly level ridgetops. Labette soils are underlain by limestone at a depth of 20 to 40 inches and are on slopes similar to those of the Irwin soils. Ladysmith soils have a grayer subsoil and are on less sloping areas.

Typical pedon of Irwin silty clay loam, 1 to 3 percent slopes, 2,190 feet west and 75 feet north of the southeast corner of sec. 32, T. 19 S., R. 5 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; hard, friable; few fine roots; slightly acid; clear smooth boundary.

AB—7 to 13 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; strong fine subangular blocky structure; hard, firm; few fine roots; slightly acid; clear smooth boundary.

Bt1—13 to 21 inches; dark brown (10YR 4/3) silty clay, dark brown (10YR 3/3) moist; moderate medium blocky structure; very hard, very firm; few fine roots; thin continuous clay films on faces of peds; neutral; gradual smooth boundary.

Bt2—21 to 40 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; moderate medium blocky structure; very hard, very firm; few fine roots; thick continuous clay films on faces of peds; few fine lime concretions in the lower four inches; mildly alkaline; gradual smooth boundary.

C—40 to 60 inches; brown (7.5YR 5/4) silty clay, brown (7.5YR 3/4) moist; common medium distinct yellowish red (5YR 4/6) mottles; massive; very hard, very firm; few fine roots; few small fragments of shale and limestone; moderately alkaline.

The thickness of the solum ranges from 30 to 60 inches. A few pedons have limestone or shale bedrock at a depth of 40 to 60 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly silty clay loam, but the range includes silt loam. Reaction ranges from medium acid to neutral.

The Bt horizon has hue of 10YR or 7.5YR, value of 4 to 6 (3 or 4 moist), and chroma of 2 or 3. It is clay or silty clay and ranges from medium acid to mildly alkaline.

The C horizon has hue of 10YR to 5YR, value of 4 to 6 (3 or 4 moist), and chroma of 2 to 5. It is clay or silty clay and ranges from neutral to moderately alkaline.

Kipson Series

The Kipson series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in material weathered from calcareous silty shale (fig. 15). Slope ranges from 10 to 25 percent.

Kipson soils are similar to Clime soils and are commonly adjacent to Clime, Hedville, and Irwin soils. Clime soils have a clayey subsoil and are 20 to 40 inches deep to shale bedrock. Irwin soils have a clayey subsoil and are more than 40 inches deep to bedrock. They are on less sloping ridgetops. Hedville soils have sandstone bedrock at a depth of less than 20 inches and are on ridgetops and upper side slopes.

Typical pedon of Kipson silty clay loam, 10 to 25 percent slopes, 1,720 feet north and 1,600 feet west of the southeast corner of sec. 15, T. 17 S., R. 2 E.

A—0 to 9 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; strong fine and medium granular structure; slightly hard, friable; many fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

AC—9 to 16 inches; light yellowish brown (10YR 6/4) silty clay loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; slightly hard, friable; few fine roots; few shale fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C—16 to 20 inches; very pale brown (10YR 7/4) shaly silty clay loam, yellowish brown (10YR 5/6) moist; massive; slightly hard, friable; few very fine roots; 30 percent shale fragments 1/4 to 1/2 inch in size; violent effervescence; moderately alkaline; clear smooth boundary.

Cr—20 inches; yellow (10YR 7/6) silty, calcareous shale.

The thickness of the solum ranges from 6 to 16 inches. Depth to shale bedrock ranges from 15 to 20 inches. Some pedons do not have lime in the upper 3 inches.

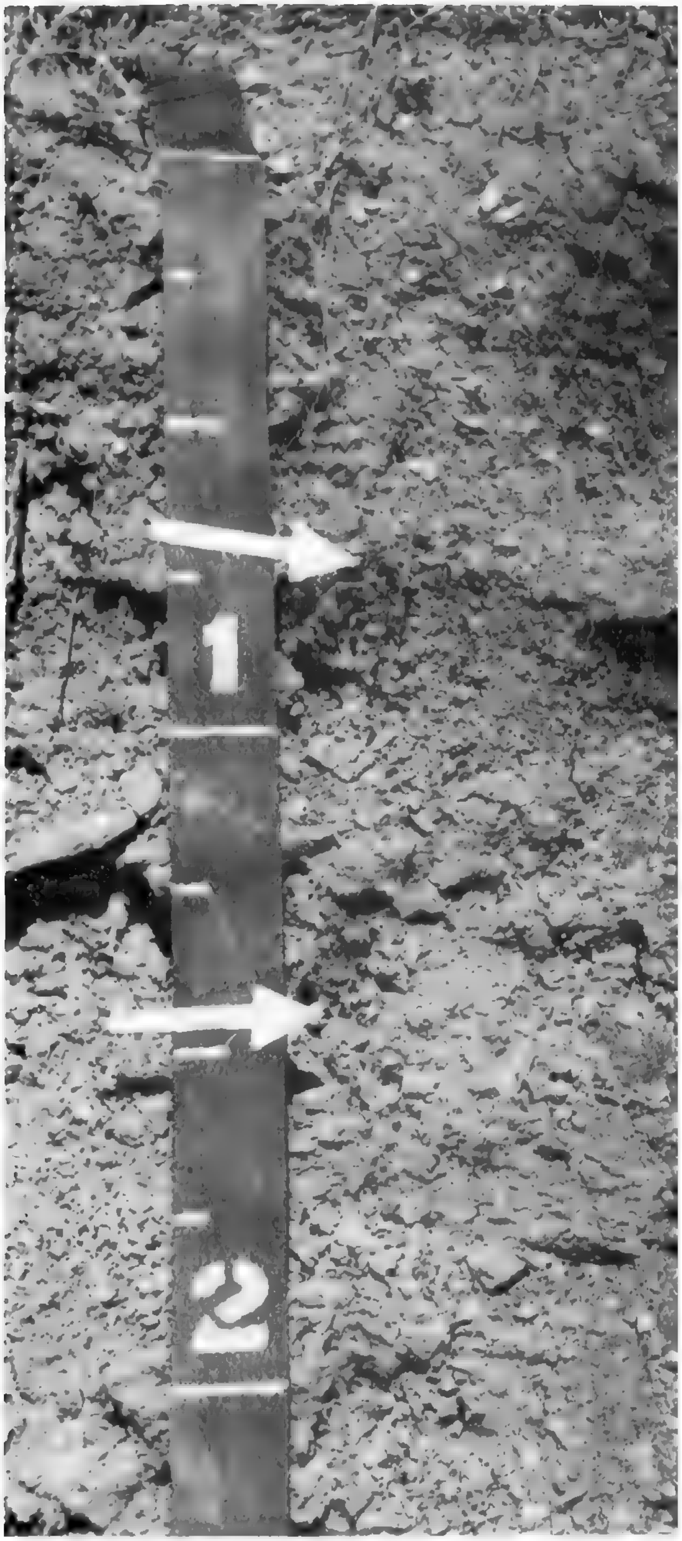

Figure 15.—The upper arrow shows the thickness of the surface layer, and the lower arrow shows the depth to shale in this Kipson soil. Depth is shown in feet.

The A horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay loam but the range includes silt loam and stony silt loam.

The AC and C horizons have hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 6. They are silty clay loam, shaly silty clay loam, or shaly silt loam. Some pedons contain 5 to 15 percent limestone fragments that are 1 to 2 inches thick.

Labette Series

The Labette series consists of moderately deep, well drained, slowly permeable soils on uplands. These soils formed in residuum of limestone. Slope ranges from 1 to 8 percent.

Labette soils are similar to Edalgo soils and are commonly adjacent to Dwight, Irwin, and Sogn soils. Edalgo soils have shale at a depth of 20 to 40 inches and are on steeper slopes. Irwin soils are more than 40 inches deep over bedrock and are on slopes similar to those of the Labette soils. Dwight soils have a natric horizon and a thinner surface layer. They are on landscape positions similar to those of Labette soils. Sogn soils are less than 20 inches deep over bedrock and are on narrow ridgetops and upper side slopes.

Typical pedon of Labette silty clay loam, 1 to 4 percent slopes, 850 feet east and 200 feet north of the southwest corner of sec. 11, T. 20 S., R. 5 E.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; hard, friable; many fine roots; slightly acid; gradual smooth boundary.

AB—8 to 15 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; hard, firm; many fine roots; slightly acid; gradual smooth boundary.

Bt1—15 to 22 inches; dark brown (7.5YR 4/4) silty clay, dark brown (7.5YR 3/4) moist; moderate medium blocky structure; very hard, very firm; many fine roots; thick continuous clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt2—22 to 31 inches; brown (7.5YR 5/4) silty clay, dark brown (7.5YR 4/4) moist; moderate medium blocky structure; very hard, very firm; few fine roots; thin continuous clay films on faces of peds; few fine lime concretions; neutral; gradual smooth boundary.

C—31 to 36 inches; brown (7.5YR 5/4) silty clay, dark brown (7.5YR 4/4) moist; few fine distinct yellowish red (5YR 5/6) mottles; massive; very hard, very firm; few fine roots; few small fragments of limestone; mildly alkaline; abrupt smooth boundary.

R—36 inches; hard, jointed limestone.

The thickness of the solum and depth to bedrock range from 20 to 40 inches.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam. It is medium acid or slightly acid.

The Bt horizon has hue of 7.5YR, 5YR, or 2.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 6. It is silty clay loam or silty clay with 35 to 50 percent clay. Reaction ranges from slightly acid to mildly alkaline.

The C horizon has hue of 7.5YR, 5YR, or 2.5YR, value of 5 or 6 dry (4 or 5 moist), and chroma of 4 to 8. Reaction ranges from neutral to moderately alkaline.

Ladysmith Series

The Ladysmith series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in old alluvial sediments. Slope ranges from 0 to 2 percent.

Ladysmith soils are similar to Goessel soils and are commonly adjacent to Goessel, Irwin, and Wells soils. Goessel soils have a clayey surface layer. Irwin soils are browner in the upper part of the subsoil and are on lower landscape positions. Wells soils have a loamy subsoil and are on higher, convex slopes.

Typical pedon of Ladysmith silty clay loam, 0 to 2 percent slopes, 2,190 feet east and 100 feet north of the southwest corner of sec. 14, T. 17 S., R. 3 E.

Ap—0 to 9 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable; few fine roots; medium acid; clear smooth boundary.

Bt—9 to 24 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; some black (10YR 2/1) streaks 1/4 inch wide; moderate medium blocky structure; very hard, very firm; thick continuous clay films on faces of peds; few fine roots; slightly acid; gradual smooth boundary.

Btg—24 to 36 inches; gray (10YR 5/1) silty clay, dark gray (10YR 4/1) moist; few fine faint yellowish brown (10YR 5/6) mottles; weak medium blocky structure; very hard, very firm; thin continuous clay films on faces of peds; few fine roots; neutral; gradual smooth boundary.

BCg—36 to 52 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; many coarse distinct yellowish red (5YR 4/6) mottles; weak coarse blocky structure; very hard, very firm; thin patchy clay films on faces of peds; few fine lime concretions; mildly alkaline; gradual irregular boundary.

Cg—52 to 60 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; common coarse distinct yellowish red (5YR 4/6) mottles; massive; very hard, very firm; few fine lime concretions; mildly alkaline.

The thickness of the solum ranges from 36 to 60 inches. The mollic epipedon is 20 to 40 inches thick. Some pedons do not have lime concretions throughout.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam. It ranges from medium acid to neutral.

The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5 (3 or 4 moist), and chroma of 1 or 2. It is silty clay or clay and contains 40 to 60 percent clay. Reaction ranges from slightly acid to mildly alkaline in the upper part and from neutral to moderately alkaline in the lower part.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 1 to 3. It is silty clay loam, clay, or silty clay. Reaction ranges from neutral to moderately alkaline.

Lancaster Series

The Lancaster series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in residuum of noncalcareous sandstone and sandy shales. Slope ranges from 1 to 12 percent.

Lancaster soils are similar to Wells soils and are commonly adjacent to Edalgo, Hedville, and Wells soils. Wells soils are more than 40 inches deep to bedrock. Edalgo soils have a clayey subsoil and are on lower side slopes. Hedville soils are less than 20 inches deep over sandstone and are on steeper upper side slopes and narrow ridgetops.

Typical pedon of Lancaster loam, 1 to 3 percent slopes, 1,500 feet west and 1,000 feet north of the southeast corner of sec. 4, T. 17 S., R. 1 E.

Ap—0 to 7 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; moderate fine granular structure; slightly hard, friable; many fine roots; a few sandstone fragments, slightly acid; abrupt smooth boundary.

BA—7 to 14 inches; brown (7.5YR 5/2) sandy clay loam, dark brown (7.5YR 3/2) moist; weak fine subangular blocky parting to moderate medium granular structure; hard, friable; few fine roots; slightly acid; gradual smooth boundary.

Bt—14 to 25 inches; reddish brown (5YR 5/4) clay loam, dark reddish brown (5YR 3/4) moist; moderate medium prismatic parting to moderate medium subangular blocky structure; very hard, firm; many fine roots; thin patchy clay films on faces of peds; neutral; gradual smooth boundary.

BC—25 to 35 inches; reddish brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) moist; weak coarse subangular blocky structure; very hard, friable; common fine roots; 10 percent sandstone fragments less than 3 inches in diameter; neutral; gradual irregular boundary.

Cr—35 inches; soft brown (10YR 5/3) sandstone.

The thickness of the solum and depth to sandy shale or soft sandstone bedrock range from 20 to 40 inches. The mollic epipedon is 8 to 20 inches thick. Sandstone fragments, 1 to 15 inches in diameter, range from 0 to 15 percent in the solum.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly loam, but the range includes sandy loam. It is medium acid or slightly acid.

The Bt horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 5. It is clay loam or sandy clay loam and is slightly acid or neutral. Some pedons have mottles below a depth of 20 inches.

Osage Series

The Osage series consists of deep, poorly drained, very slowly permeable soils on flood plains. These soils formed in thick clayey alluvium. Slope ranges from 0 to 1 percent.

The annual temperature of the Osage soils in this county is a few degrees cooler than is definitive for the Osage series. This difference, however, does not alter the use and behavior of the soils.

Osage soils are similar to Chase soils and are commonly adjacent to Chase, Reading, and Verdigris soils. Chase soils have an argillic horizon and are on low stream terraces. Reading and Verdigris soils have a silty subsoil. Reading soils are on terraces, and Verdigris soils are on flood plains adjacent to stream channels.

Typical pedon of Osage silty clay, 1,500 feet north and 150 feet east of the southwest corner of sec. 31, T. 20 S., R. 5 E.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; strong fine granular structure; hard, firm; many fine roots; medium acid; clear smooth boundary.

A—8 to 21 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; strong fine blocky structure; very hard, very firm; few fine roots; medium acid; gradual smooth boundary.

Bg—21 to 29 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; few fine faint very dark grayish brown (2.5Y 3/2) and very dark gray (N 3/0) mottles; weak medium blocky structure; extremely hard, extremely firm; few slickensides; few fine roots; slightly acid; gradual smooth boundary.

BCg—29 to 44 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; common medium distinct olive brown (2.5Y 4/4) mottles; weak medium blocky structure; extremely hard, extremely firm; few dark brown stains; common slickensides; neutral; gradual smooth boundary.

Cg—44 to 60 inches; dark gray (5Y 4/1) silty clay, very dark gray (5Y 3/1) moist; common medium distinct olive brown (2.5Y 4/4) mottles; massive; extremely hard, extremely firm; common slickensides; common fine lime concretions; neutral.

The thickness of the solum ranges from 40 to 60 inches.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay or clay, but the range includes silty clay loam. Reaction ranges from strongly acid to neutral.

The Bg horizon has no hue or has hue of 10YR or 2.5Y, value of 4 or 5 (3 moist), and chroma of less than 2.

The BC and C horizons have hue of 10YR to 5Y or are neutral, and they have value of 4 to 7 (3 to 6 moist) and chroma of less than 1.5. They are clay or silty clay.

Reading Series

The Reading series consists of deep, well drained, moderately slowly permeable soils on stream terraces. These soils formed in silty alluvium. Slope ranges from 0 to 2 percent.

Reading soils are similar to Verdigris soils and are commonly adjacent to Chase, Verdigris, and Wells soils. Verdigris soils do not have an argillic horizon and are on flood plains. Chase soils have a clayey subsoil and are on lower stream terraces. Wells soils have a redder subsoil and are on uplands.

Typical pedon of Reading silt loam, 2,190 feet west and 120 feet south of the northeast corner of sec. 16, T. 21 S., R. 5 E.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; many fine roots; slightly acid; abrupt smooth boundary.

A—6 to 12 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.

BA—12 to 18 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; moderate fine subangular blocky structure; hard, firm; few fine roots; slightly acid; gradual smooth boundary.

Bt—18 to 32 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, firm; few fine roots; thin patchy clay films on faces of peds; slightly acid; gradual smooth boundary.

BC—32 to 42 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; hard, firm; few fine roots; thin patchy clay films on faces of peds; few small

limestone fragments; slightly acid; gradual smooth boundary.
C—42 to 60 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; massive; hard, firm; neutral.

The thickness of the solum ranges from 40 to more than 60 inches. The mollic epipedon is more than 24 inches thick. The solum is medium acid or slightly acid.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. It is silt loam or silty clay loam.

The Bt horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 to 4 moist), and chroma of 2 to 4.

The C horizon has hue of 7.5YR or 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 to 4. It is silty clay loam or clay loam. It is neutral or mildly alkaline.

Rosehill Series

The Rosehill series consists of moderately deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in residuum from clayey shale. Slope ranges from 1 to 3 percent.

Rosehill soils are similar to Clime soils and are commonly adjacent to Goessel, Irwin, and Clime soils. Clime soils have lime within a depth of 10 inches and are on steeper side slopes. Goessel soils are more than 40 inches deep over bedrock and are on nearly level ridgetops. Irwin soils have an argillic horizon and a less clayey surface layer and are on ridgetops.

Typical pedon of Rosehill silty clay, 1 to 3 percent slopes, 2,290 feet north and 100 feet west of the southeast corner of sec. 32, T. 19 S., R. 2 E.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; weak fine granular structure; very hard, firm; few fine roots; slightly acid; clear smooth boundary.
Bw1—8 to 20 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; some streaks of black (10YR 2/1) 1/4 to 1/2 inch wide; weak fine blocky structure; extremely hard, extremely firm; few fine roots; neutral; gradual smooth boundary.
Bw2—20 to 28 inches; pale olive (5Y 6/3) silty clay, olive (5Y 5/3) moist; few fine faint light olive brown (2.5Y 5/6) mottles; weak medium blocky structure; extremely hard, extremely firm; few fine lime concretions; neutral; gradual smooth boundary.
Cr—28 inches; pale olive (5Y 6/3) clayey shale; thin seams of soft lime.

The thickness of the solum and the depth to clayey shale range from 20 to 40 inches.

The A horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay, but the range includes silty clay loam. It is slightly acid or neutral.

The Bw horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 7 (3 to 6 moist), and chroma of 2 to 4. It is silty clay or clay, and reaction ranges from neutral to moderately alkaline.

Sogn Series

The Sogn series consists of shallow and very shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in residuum of limestone (fig. 16). Slope ranges from 0 to 15 percent.

Sogn soils are similar to Hedville soils and are commonly adjacent to Clime, Dwight, Labette, and Tully soils. Hedville soils contain more sand and are underlain by sandstone. Clime soils have a clayey subsoil and are underlain by shale at a depth of 20 to 40 inches. They are on lower side slopes. Dwight, Labette, and Tully soils have an argillic horizon and are more than 20 inches deep over bedrock. Dwight and Labette soils are on ridgetops above Sogn soils. Tully soils are on foot slopes.

Typical pedon of Sogn silty clay loam, 0 to 15 percent slopes, 1,600 feet south and 620 feet east of the northwest corner of sec. 15, T. 21 S., R. 5 E.

A—0 to 8 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate medium and coarse granular structure; hard, friable; many fine roots; slightly acid; abrupt smooth boundary.
R—8 inches; horizontally bedded, hard limestone.

The thickness of the solum and depth to limestone range from 4 to 20 inches. Reaction in the solum ranges from slightly acid to moderately alkaline.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly silty clay loam, but the range includes silt loam. Some pedons contain lime and limestone fragments.

Tully Series

The Tully series consists of deep, well drained, slowly permeable soils on foot slopes. These soils formed in colluvium. Slope ranges from 2 to 6 percent (fig. 17).

Tully soils are similar to Irwin soils and are commonly adjacent to Clime, Labette, and Sogn soils. Irwin soils are moderately well drained, have a thinner surface soil, and are on ridgetops. Clime soils are 20 to 40 inches deep over shale and are on upper side slopes. Labette soils are underlain by hard limestone at a depth of 20 to 40 inches and are on ridgetops. Sogn soils are underlain by hard limestone at a depth of less than 20 inches and are on ridgetops and upper side slopes.

Figure 16.—Arrow shows the depth of this Sogn soil over limestone rock. Depth is shown in feet.

Typical pedon of Tully silty clay loam, 2 to 6 percent slopes, 1,560 feet west and 650 feet north of the southeast corner of sec. 35, T. 18 S., R. 4 E.

A—0 to 12 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; strong medium granular structure; hard, friable; many fine roots; neutral; clear smooth boundary.

AB—12 to 17 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; strong fine subangular blocky structure; very hard, firm; many fine roots; neutral; clear smooth boundary.

Bt1—17 to 25 inches; dark brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) moist; moderate medium blocky structure; thin continuous clay films on faces of peds; very hard, very firm; many fine roots; neutral; gradual smooth boundary.

Bt2—25 to 36 inches; brown (7.5YR 5/2) silty clay, dark brown (7.5YR 4/2) moist; strong medium blocky structure; thin patchy clay films on faces of peds; very hard, very firm; few fine roots; mildly alkaline; gradual smooth boundary.

BC—36 to 42 inches; dark brown (7.5YR 4/4) silty clay, dark brown (7.5YR 3/4) moist; weak medium blocky structure; very hard, firm; few fine roots; few fine lime concretions; mildly alkaline; gradual smooth boundary.

C—42 to 60 inches; reddish brown (5YR 5/4) silty clay, reddish brown (5YR 4/4) moist; massive; hard, firm; few fine lime concretions; few fine black concretions; mildly alkaline.

The thickness of the solum ranges from 36 to 60 inches. Depth to lime is more than 30 inches. The mollic epipedon is 20 to 40 inches thick. Chert fragments range from 0 to 5 percent throughout the soil.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly silty clay loam, but the range includes silt loam. Reaction ranges from medium acid to neutral.

The Bt horizon has hue of 10YR or 7.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. It ranges from slightly acid to moderately alkaline.

The C horizon has hue of 7.5YR or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 6. It is clay, silty clay, or silty clay loam. Reaction ranges from neutral to moderately alkaline. Some pedons do not have lime concretions throughout.

Verdigris Series

The Verdigris series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slope ranges from 0 to 2 percent.

The annual temperature of the Verdigris soils in this county is a few degrees cooler than is definitive for the

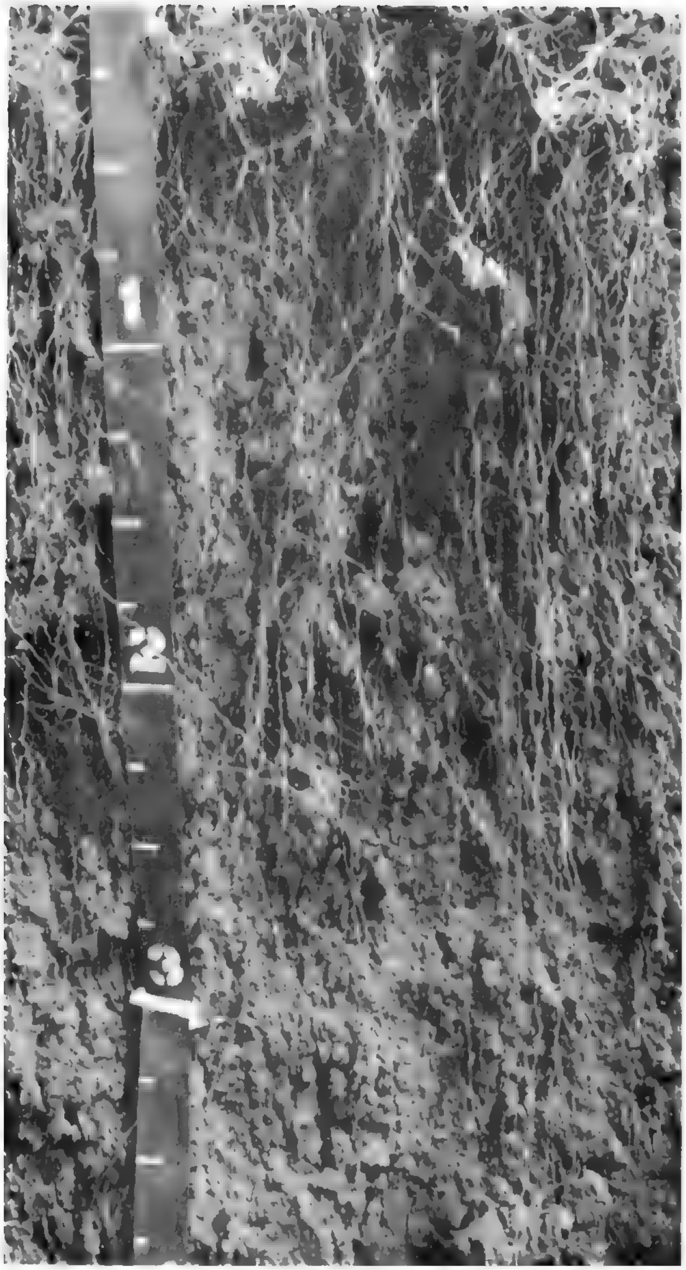

Figure 17.—This Tully soil contains many roots to a depth of 25 inches. Depth is shown in feet.

Verdigris series. This difference, however, does not alter the use and behavior of the soils.

Verdigris soils are similar to Reading soils and are commonly adjacent to Chase and Reading soils. Reading and Chase soils have an argillic horizon, and in addition, Chase soils have a more clayey subsoil. Chase and Reading soils are on stream terraces. Cass soils have a sandier subsoil and are on a similar position on the landscape.

Typical pedon of Verdigris silt loam, 2,200 feet north and 1,800 feet west of the southeast corner of sec. 1, T. 21 S., R. 4 E.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, friable; many fine roots; neutral; clear smooth boundary.

A—9 to 22 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium granular structure; hard, friable; few fine roots; neutral; gradual smooth boundary.

AC—22 to 40 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; hard, friable; few fine roots; neutral; gradual smooth boundary.

C—40 to 60 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable; few fine roots; neutral.

The thickness of the solum ranges from 30 to 60 inches. The mollic epipedon is more than 24 inches thick. The soil ranges from medium acid to neutral.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly silt loam, but range includes silty clay loam.

The C horizon has hue of 10YR or 7.5YR, value of 5 to 7 (3 to 6 moist), and chroma of 2 to 4. It is silt loam, loam, or silty clay loam. In some pedons, the C horizon contains faint mottles of high chroma. Some pedons are sandy loam below a depth of 40 inches.

Wells Series

The Wells series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in old alluvium or in residuum from noncalcareous sandstone. Slope ranges from 1 to 7 percent.

Wells soils are similar to Lancaster soils and are commonly adjacent to Irwin, Lancaster, and Verdigris soils. Lancaster soils are 20 to 40 inches deep over sandstone. Irwin soils have a more clayey subsoil and are on broad ridgetops. Verdigris soils are more silty and are on flood plains.

Typical pedon of Wells loam, 1 to 3 percent slopes, 2,200 feet west and 400 feet south of the northeast corner of sec. 14, T. 20 S., R. 1 E.

Ap—0 to 9 inches; dark brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; weak fine granular structure; soft, very friable; many fine roots; slightly acid; clear smooth boundary.

BA—9 to 15 inches; dark reddish gray (5YR 4/2) loam, dark reddish brown (5YR 3/2) moist; weak medium

subangular blocky structure; slightly hard, friable; few fine roots; slightly acid; clear smooth boundary.

Bt1—15 to 28 inches; reddish brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) moist; moderate medium subangular blocky structure; hard, firm; few fine roots; neutral; gradual smooth boundary.

Bt2—28 to 36 inches; reddish brown (5YR 5/3) sandy clay loam, reddish brown (5YR 4/4) moist; weak medium subangular blocky structure; hard, firm; few fine roots; neutral; gradual irregular boundary.

C—36 to 60 inches; reddish brown (5YR 5/4) sandy loam, reddish brown (5YR 4/4) moist; massive; slightly hard, friable; neutral.

The thickness of the solum ranges from 35 to 55 inches. Thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is dominantly loam or clay loam, but the range includes fine sandy loam. Reaction is medium acid or slightly acid.

The Bt horizon has hue of 5YR or 7.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6. It is sandy clay loam or clay loam. Reaction is slightly acid or neutral.

The C horizon has hue of 5YR or 7.5YR, value of 5 or 6 (4 to 6 moist), and chroma of 4 to 6. It is sandy loam or sandy clay loam. Reaction is slightly acid or neutral.

Formation of the Soils

This section discusses the factors and processes of soil formation and relates them to the formation of soils in the survey area.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given place are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. As rocks are weathered, they disintegrate into parent material. The combined effects of climate and plant and animal life slowly change the parent material into a natural body that has genetically related horizons. The effects of climate and of plant and animal life are conditioned by relief. The parent material itself also affects the nature of the soil that is formed. Finally, time is needed for changing the parent material into a soil. Usually a long time is required for the development of distinct horizons within the soil.

The factors are so closely interrelated in their effect on soil formation that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. The five major factors of soil formation are discussed in relation to their effects on the soils of Marion County.

Parent Material

Parent material is the unconsolidated material from which soil is formed. Parent material forms by the weathering of rocks through the processes of freezing and thawing, abrasion, erosion, deposition by wind and water, and the operation of chemical processes.

The parent materials of Marion County soils are limestone, cherty limestone, calcareous and noncalcareous shales, sandstone and sandy shales, alluvium, and colluvium.

Limestone, cherty limestone, and calcareous shales date back to Early and Middle Permian age and outcrop extensively over the eastern two-thirds of the county (*3*). These rocks make up the oldest geologic formation in the county, and they occur in alternating beds. Sogn and Labette soils formed in residuum of limestone, and Florence soils formed in material weathered from cherty limestone. The Clime and Kipson soils formed in material weathered from calcareous shales. Dwight and Rosehill soils formed in sediments from noncalcareous shales.

The sandstone and sandy shales are of Early Cretaceous age and consist of Kiowa shale and Dakota sandstone. They are found mainly in the northwestern part of the county. Hedville, Edalgo, and Lancaster soils formed in residuum from these rocks.

Alluvium, colluvium, and loess parent materials are derived from sediments deposited by wind and streams during the Quaternary Period. The Goessel, Irwin, and Ladysmith soils formed in old alluvium on uplands. The more recently deposited alluvium is along streams, and soils that have formed in these deposits include Cass, Chase, Osage, Reading, and Verdigris soils. Tully soils formed in colluvium that mantles foot slopes, mainly in the eastern half of the county.

Climate

Climate is an active factor of soil formation. It directly affects the type of soil profile that forms by causing the weathering of the parent material. Its effect on plants and animals indirectly affects soil formation.

The climate of Marion County is continental and is characterized by intermittent dry and moist periods. These changes can occur within a year or in cycles of several years. The soil material dries to varying depths during dry periods. It slowly regains moisture during wet periods and can become so saturated that excess moisture penetrates the substratum.

This wetting and drying has helped in the development of soils by leaching basic nutrients and even clay particles from the upper horizons. Mature soils have distinct horizons. In Marion County, soils having well developed horizons are generally on nearly level to gently sloping areas rather than on steeper areas. Examples of mature soils that have distinct horizons are Irwin and Ladysmith soils. As a result of leaching, these soils have a silty surface layer over a clayey subsoil.

Freezing and thawing modifies soil structure. In clay soils, freezing and thawing tends to create soil aggregates, thus forming a granular structure that is desirable in farming operations. Granular structure, which

is common in the spring after a period of freezing and thawing, is particularly noticeable in the surface layer of Goessel, Osage, and Rosehill soils. Excessive tillage destroys the granular structure.

Plant and Animal Life

All plants and animals are important to soil formation. Plants generally influence the amount of nutrients and of organic matter in the soil and the color of the surface layer. Animals such as earthworms, cicadas, and burrowing animals help keep the soil open and porous. Bacteria and fungi facilitate plant decomposition, which releases more nutrients for plant food.

Mid and tall prairie grasses have had a great influence on soil formation in Marion County. The decomposed remains of these grasses have accumulated over a long period of time. As a result, a typical soil in the county has a dark upper part that is high in organic matter.

Relief

Relief, or lay of the land, influences the formation of soils by the effect it has on drainage, runoff, plant cover, and soil temperature. Although climate and plants are the most active agents in the formation of soils, relief is important because it modifies the change from parent materials into soil. Relief is an influence mainly because it controls the movement of water on the surface and into the soil.

Soils on strongly sloping uplands undergo more runoff and erosion of soil materials. The Hedville soils formed in old parent material, but the relief has restricted development of these soils. Runoff is rapid on the steeper slopes, and much of the soil material is removed as fast as it forms.

Nearly level soils on uplands generally have a more strongly developed profile than do steeper soils because the slower rate of runoff in the level areas allows more water to percolate through the soil and lessens the removal of soil from the surface. On low and flat topography, the soil generally receives extra water in the form of runoff from higher lying soils. The additional water produces gray or mottled colors in the subsoil. Chase, Ladysmith, and Osage soils show mottling as a result of water accumulation.

Time

In the formation of soils, a long time generally is needed for distinct horizons in the soil to form. Differences in the degree of profile development among the soils commonly reflect differences in the length of time that the parent materials have been in place.

The soils in Marion County range from immature to mature. Those on flood plains, such as Verdigris soils, receive new sediment with each flooding. These soils have a thick, dark surface layer, but they have weakly expressed horizons. As a result, they are considered immature. Some soils have weakly expressed horizons because they have been forming in residuum of rock that is highly resistant to weathering. Sogn soils are an example. Among the oldest and most mature soils in the county are the Wells soils, which formed in old alluvium and have well expressed horizons.

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Glossary

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Argillic horizon. A subsoil horizon characterized by an accumulation of clay.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedding. A method of draining soil by elevating, grading, or plowing it into a series of broad beds separated by shallow surface drains.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse fragments. Mineral or mica particles larger than 2 millimeters in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The

composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—Readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—Adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Deferred grazing. Postponing grazing or resting grazingland for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Edge habitat. The zone of transition from one type of plant cover to another.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual.* The major horizons of mineral soil are as follows:
O horizon.—An organic layer of fresh and decaying plant residue.
A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of another horizon.
E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.
B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.
C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Arabic numeral 2 precedes the letter C.
R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A, E, or B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly

deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Intermittent stream. A stream, or reach of a stream, that flows for protracted periods only when it receives ground-water discharge or long-continued contributions from melting snow or other surface and shallow subsurface sources.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Mollic epipedon. A thick, dark surface soil which may also include part of the subsoil. It has a high base saturation and a relatively soft consistency.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can

be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^+ to $Ca^{++} + Mg^{++}$. The degrees of sodicity are—

	SAR
Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, EB) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. Includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Toxicity (in tables). Excessive amount of toxic substances, such as sodium or sulfur, that severely hinder establishment of vegetation or severely restrict plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-76 at Florence, Kansas]

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	41.3	18.3	29.8	68	-10	0.67	0.14	1.19	2	4.7
February---	48.0	23.6	35.8	78	- 2	1.01	0.33	1.60	3	4.4
March------	56.6	31.0	43.8	85	2	1.87	0.68	2.38	4	3.7
April------	69.4	43.6	56.5	89	21	2.98	1.74	4.26	5	0.2
May--------	78.1	53.0	65.6	96	30	4.88	3.56	5.51	8	---
June-------	87.0	62.8	74.9	103	43	5.10	2.05	7.15	7	---
July-------	93.0	67.3	80.2	107	49	3.80	1.60	5.91	6	---
August-----	92.1	65.7	78.9	106	47	2.94	0.67	3.94	5	---
September--	82.7	56.6	69.7	102	34	4.07	1.15	6.95	5	---
October----	72.5	45.6	59.1	94	22	2.99	0.76	4.85	4	---
November---	56.2	32.1	44.2	78	6	1.54	0.07	2.46	2	1.9
December---	44.9	22.8	33.9	69	- 6	1.00	0.37	1.61	2	3.4
Year-----	68.5	43.5	56.0	107	-10	32.85	22.06	40.74	53	18.3

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Minimum temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 12	April 25	May 7
2 years in 10 later than--	April 7	April 20	May 2
5 years in 10 later than--	March 29	April 10	April 22
First freezing temperature in fall:			
1 year in 10 earlier than--	October 23	October 17	October 5
2 years in 10 earlier than--	October 27	October 22	October 9
5 years in 10 earlier than--	November 6	October 31	October 19

TABLE 3.--GROWING SEASON

Probability	Length of growing season if the daily minimum temperature is--		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	201	183	158
8 years in 10	208	190	165
5 years in 10	222	204	180
2 years in 10	235	218	194
1 year in 10	242	225	201

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ca	Cass fine sandy loam	790	0.1
Ch	Chase silty clay loam	12,060	1.9
Cm	Clime silty clay loam, 1 to 3 percent slopes	62,500	10.2
Cp	Clime silty clay loam, 3 to 7 percent slopes	25,740	4.2
Cr	Clime stony silty clay loam, 15 to 30 percent slopes	720	0.1
Cs	Clime-Sogn silty clay loams, 3 to 20 percent slopes	17,530	2.8
Dw	Dwight silt loam, 0 to 2 percent slopes	4,520	0.7
Ed	Edalgo silty clay loam, 3 to 12 percent slopes	2,280	0.4
Fc	Florence silt loam, 2 to 15 percent slopes	4,150	0.7
Go	Goessel silty clay	10,180	1.6
Ib	Irwin silty clay loam, 1 to 3 percent slopes	177,350	28.9
Ic	Irwin silty clay loam, 3 to 6 percent slopes	11,670	1.9
Kp	Kipson silty clay loam, 10 to 25 percent slopes	4,100	0.7
La	Labette silty clay loam, 1 to 4 percent slopes	13,730	2.2
Ld	Labette-Dwight complex, 1 to 3 percent slopes	12,790	2.1
Lg	Labette-Sogn silty clay loams, 2 to 15 percent slopes	21,220	3.5
Lm	Ladysmith silty clay loam, 0 to 2 percent slopes	30,580	5.0
Ls	Lancaster loam, 1 to 3 percent slopes	6,000	1.0
Lt	Lancaster loam, 3 to 7 percent slopes	10,960	1.8
Lv	Lancaster-Hedville complex, 3 to 20 percent slopes	7,090	1.2
Os	Osage silty clay	640	0.1
Pt	Pits, quarries	300	*
Re	Reading silt loam	7,040	1.1
Rh	Rosehill silty clay, 1 to 3 percent slopes	20,600	3.4
So	Sogn silty clay loam, 0 to 15 percent slopes	16,900	2.8
Tu	Tully silty clay loam, 2 to 6 percent slopes	28,900	4.7
Vb	Verdigris silt loam	25,850	4.2
Vc	Verdigris silt loam, channeled	22,500	3.6
Wb	Wells loam, 1 to 3 percent slopes	33,650	5.5
Wc	Wells loam, 3 to 7 percent slopes	8,460	1.4
Wd	Wells clay loam, 3 to 7 percent slopes, eroded	4,000	0.7
	Water	8,960	1.5
	Total	613,760	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Grain sorghum	Winter wheat	Alfalfa hay	Soybeans
	Bu	Bu	Ton	Bu
Ca: Cass	60	36	4.0	---
Ch: Chase	64	40	4.5	36
Cm: Clime	50	33	1.8	22
Cp: Clime	46	30	1.6	18
Cr: Clime	---	---	---	---
Cs: Clime-Sogn	---	---	---	---
Dw: Dwight	44	28	1.5	---
Ed: Edalgo	---	---	---	---
Fc: Florence	---	---	---	---
Go: Goessel	54	36	3.0	24
Ib: Irwin	56	37	3.0	24
Ic: Irwin	52	34	2.6	20
Kp: Kipson	---	---	---	---
La: Labette	56	37	3.0	23
Ld: Labette-Dwight	52	32	2.5	---
Lg: Labette-Sogn	---	---	---	---
Lm: Ladysmith	58	38	3.0	26
Ls: Lancaster	62	35	3.0	---
Lt: Lancaster	58	32	3.0	---
Lv: Lancaster-Hedville	---	---	---	---
Os: Osage	56	36	---	30

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Grain sorghum	Winter wheat	Alfalfa hay	Soybeans
	Bu	Bu	Ton	Bu
Pt*. Pits				
Re Reading	68	42	4.5	35
Rh Rosehill	50	31	1.8	22
So Sogn	---	---	---	---
Tu Tully	56	35	3.3	---
Vb Verdigris	62	36	5.0	35
Vc Verdigris	---	---	---	---
Wb Wells	60	38	4.0	30
Wc Wells	55	34	3.5	24
Wd Wells	50	30	3.0	22

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ca: Cass	Sandy Lowland	Favorable	5,500	Big bluestem	35
		Normal	4,000	Switchgrass	15
		Unfavorable	3,000	Indiangrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
Ch: Chase	Loamy Lowland	Favorable	10,000	Big bluestem	30
		Normal	8,500	Prairie cordgrass	15
		Unfavorable	6,000	Indiangrass	15
				Switchgrass	10
				Eastern gamagrass	10
Cm, Cp, Cr: Clime	Limy Upland	Favorable	5,000	Little bluestem	30
		Normal	3,500	Big bluestem	20
		Unfavorable	2,500	Sideoats grama	15
				Indiangrass	5
				Switchgrass	5
				Blue grama	5
Cs*:					
Clime	Limy Upland	Favorable	5,000	Little bluestem	30
		Normal	3,500	Big bluestem	20
		Unfavorable	2,500	Sideoats grama	15
				Indiangrass	5
				Switchgrass	5
				Blue grama	5
Sogn	Shallow Limy	Favorable	3,500	Sideoats grama	25
		Normal	2,500	Big bluestem	15
		Unfavorable	1,500	Little bluestem	15
				Indiangrass	5
				Switchgrass	5
				Tall dropseed	5
				Blue grama	5
Dw: Dwight	Claypan	Favorable	4,000	Big bluestem	15
		Normal	3,000	Little bluestem	10
		Unfavorable	2,000	Tall dropseed	10
				Blue grama	10
				Western wheatgrass	10
				Switchgrass	10
				Sideoats grama	10
				Dotted gayfeather	5
				Buffalograss	5
Ed: Edalgo	Clay Upland	Favorable	5,000	Big bluestem	30
		Normal	3,500	Little bluestem	15
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	10
				Tall dropseed	5
				Sideoats grama	5
Fc: Florence	Loamy Upland	Favorable	5,500	Big bluestem	40
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Eastern gamagrass	5
				Tall dropseed	5
				Sideoats grama	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Go: Goessel	Clay Upland	Favorable	5,500	Big bluestem	30
		Normal	3,500	Little bluestem	20
		Unfavorable	2,000	Switchgrass	10
				Indiangrass	5
				Sideoats grama	5
				Tall dropseed	5
Ib, Ic: Irwin	Clay Upland	Favorable	5,000	Big bluestem	30
		Normal	3,500	Little bluestem	25
		Unfavorable	2,000	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
Kp: Kipson	Limy Upland	Favorable	4,500	Big bluestem	30
		Normal	3,500	Little bluestem	25
		Unfavorable	2,000	Sideoats grama	15
				Switchgrass	5
				Indiangrass	5
La: Labette	Loamy Upland	Favorable	5,500	Big bluestem	30
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	15
				Switchgrass	10
				Eastern gamagrass	5
				Compassplant	5
Ld*:					
Labette	Loamy Upland	Favorable	5,500	Big bluestem	30
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	15
				Switchgrass	10
				Eastern gamagrass	5
Dwight	Claypan	Favorable	4,000	Big bluestem	15
		Normal	3,000	Little bluestem	10
		Unfavorable	2,000	Tall dropseed	10
				Blue grama	10
				Western wheatgrass	10
				Switchgrass	10
				Sideoats grama	10
				Dotted gayfeather	5
				Buffalograss	5
Lg*:					
Labette	Loamy Upland	Favorable	5,500	Big bluestem	30
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	15
				Switchgrass	10
				Eastern gamagrass	5
Sogn	Shallow Limy	Favorable	3,500	Sideoats grama	25
		Normal	2,500	Big bluestem	15
		Unfavorable	1,500	Little bluestem	15
				Indiangrass	5
				Switchgrass	5
				Tall dropseed	5
				Blue grama	5
Lm: Ladysmith	Clay Upland	Favorable	5,000	Big bluestem	30
		Normal	3,500	Little bluestem	25
		Unfavorable	2,000	Switchgrass	10
				Indiangrass	5
				Tall dropseed	5
				Sideoats grama	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ls, Lt: Lancaster	Loamy Upland	Favorable	5,000	Big bluestem	30
		Normal	3,500	Little bluestem	25
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
Lv*:					
Lancaster	Loamy Upland	Favorable	5,000	Big bluestem	30
		Normal	3,500	Little bluestem	25
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
Hedville	Shallow Sandstone	Favorable	3,500	Little bluestem	35
		Normal	3,000	Big bluestem	30
		Unfavorable	2,000	Switchgrass	5
				Indiangrass	5
				Sideoats grama	5
Os: Osage	Clay Lowland	Favorable	9,000	Prairie cordgrass	35
		Normal	7,500	Big bluestem	20
		Unfavorable	5,000	Switchgrass	15
				Indiangrass	10
				Eastern gamagrass	5
Re: Reading	Loamy Lowland	Favorable	10,000	Big bluestem	40
		Normal	8,000	Indiangrass	10
		Unfavorable	6,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
Rh: Rosehill	Clay Upland	Favorable	5,500	Big bluestem	30
		Normal	3,500	Little bluestem	15
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	5
				Sideoats grama	5
				Tall dropseed	5
So: Sogn	Shallow Limy	Favorable	3,500	Sideoats grama	25
		Normal	2,500	Big bluestem	15
		Unfavorable	1,500	Little bluestem	15
				Indiangrass	5
				Switchgrass	5
				Tall dropseed	5
				Blue grama	5
Tu: Tully	Loamy Upland	Favorable	6,000	Big bluestem	40
		Normal	5,000	Little bluestem	20
		Unfavorable	3,500	Switchgrass	10
				Indiangrass	10
				Eastern gamagrass	5
Vb, Vc: Verdigris	Loamy Lowland	Favorable	10,000	Big bluestem	30
		Normal	8,500	Indiangrass	15
		Unfavorable	6,000	Eastern gamagrass	15
				Switchgrass	10
				Prairie cordgrass	5
Wb, Wc, Wd: Wells	Loamy Upland	Favorable	5,500	Big bluestem	25
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
				Tall dropseed	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
Ca: Cass	---	Peking cotoneaster, Amur honeysuckle, lilac, American plum.	Eastern redcedar	Austrian pine, hackberry, eastern white pine, honeylocust, bur oak, green ash.	Eastern cottonwood.
Ch: Chase	---	American plum, Amur honeysuckle, Peking cotoneaster, lilac.	Eastern redcedar	Austrian pine, eastern white pine, bur oak, green ash, hackberry, honeylocust.	Eastern cottonwood.
Cm, Cp, Cr: Clime	Fragrant sumac, Tatarian honeysuckle.	Siberian peashrub	Eastern redcedar, green ash, osageorange, Russian-olive, black locust, honeylocust, northern catalpa, bur oak.	Siberian elm	---
Cs*: Clime	Fragrant sumac, Tatarian honeysuckle.	Siberian peashrub	Eastern redcedar, green ash, osageorange, Russian-olive, black locust, honeylocust, northern catalpa, bur oak.	Siberian elm	---
Sogn.					
Dw: Dwight	Lilac, silver buffaloberry, Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, Russian-olive, Siberian elm, green ash.	---	---	---
Ed: Edalgo	Siberian peashrub, Amur honeysuckle, Peking cotoneaster.	Eastern redcedar, Rocky Mountain juniper.	Austrian pine, honeylocust, Russian-olive, green ash, Russian mulberry, hackberry.	Siberian elm	---
Fc: Florence	Lilac, Peking cotoneaster, Amur honeysuckle, fragrant sumac.	---	Eastern redcedar, hackberry, bur oak, Austrian pine, green ash, Russian-olive.	Honeylocust, Siberian elm.	---
Go: Goessel	Amur honeysuckle, Siberian peashrub, Peking cotoneaster.	Rocky Mountain juniper, eastern redcedar, green ash, hackberry, Russian-olive.	Austrian pine, Russian mulberry, honeylocust.	Siberian elm	---
Ib, Ic: Irwin	Lilac, Peking cotoneaster.	Manchurian crabapple, Amur honeysuckle, Siberian peashrub.	Austrian pine, eastern redcedar, hackberry, green ash, Russian-olive.	Siberian elm, honeylocust.	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Kp. Kipson					
La----------------- Labette	Lilac	Autumn-olive, Amur honeysuckle, Siberian peashrub, Manchurian crabapple.	Russian-olive, eastern redcedar, jack pine, green ash, Austrian pine, hackberry.	Honeylocust	---
Ld*: Labette	Lilac	Autumn-olive, Amur honeysuckle, Siberian peashrub, Manchurian crabapple.	Russian-olive, eastern redcedar, jack pine, green ash, Austrian pine, hackberry.	Honeylocust	---
Dwight	Lilac, silver buffaloberry, Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, Russian-olive, Siberian elm, green ash.	---	---	---
Lg*: Labette	Lilac	Autumn-olive, Amur honeysuckle, Siberian peashrub, Manchurian crabapple.	Russian-olive, eastern redcedar, jack pine, green ash, Austrian pine, hackberry.	Honeylocust	---
Sogn.					
Lm Ladysmith	Lilac, Peking cotoneaster.	Amur honeysuckle, Siberian peashrub, Manchurian crabapple.	Eastern redcedar, Austrian pine, Russian-olive, hackberry, green ash.	Siberian elm, honeylocust.	---
Ls, Lt Lancaster	Fragrant sumac, lilac, Siberian peashrub.	Rocky Mountain juniper, Russian mulberry, Russian-olive.	Eastern redcedar, green ash, Austrian pine, bur oak, honeylocust.	Siberian elm	---
Lv*: Lancaster	Fragrant sumac, lilac, Siberian peashrub.	Rocky Mountain juniper, Russian mulberry, Russian-olive.	Eastern redcedar, green ash, Austrian pine, bur oak, honeylocust.	Siberian elm	---
Hedville.					
Os Osage	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Norway spruce, honeylocust, green ash, golden willow.	Eastern cottonwood.
Pt*. Pits					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Re----------------- Reading	---	Lilac, American plum, Peking cotoneaster, Amur honeysuckle.	Eastern redcedar	Austrian pine, bur oak, green ash, honeylocust, eastern white pine, hackberry.	Eastern cottonwood.
Rh----------------- Rosehill	Amur honeysuckle, Siberian peashrub, Peking cotoneaster.	Eastern redcedar, hackberry, green ash, Russian-olive, Rocky Mountain juniper.	Austrian pine, Russian mulberry, honeylocust.	Siberian elm------	---
So. Sogn					
Tu----------------- Tully	Peking cotoneaster	Lilac, fragrant sumac, Amur honeysuckle.	Eastern redcedar, Russian-olive, hackberry, green ash, bur oak.	Austrian pine, honeylocust, Scotch pine.	---
Vb, Vc------------ Verdigris	---	American plum, lilac, Peking cotoneaster, Amur honeysuckle.	Eastern redcedar	Austrian pine, honeylocust, eastern white pine, bur oak, green ash, hackberry.	Eastern cottonwood.
Wb, Wc, Wd--------- Wells	Lilac, Amur honeysuckle, fragrant sumac.	Russian mulberry	Eastern redcedar, hackberry, Russian-olive, honeylocust, bur oak, Austrian pine, green ash.	Siberian elm------	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ca: Cass	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Ch: Chase	Severe: flooding.	Moderate: wetness, percs slowly.	Moderate: wetness, flooding, percs slowly.	Severe: erodes easily.
Cm, Cp: Clime	Slight	Slight	Moderate: slope.	Severe: erodes easily.
Cr: Clime	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Cs*:				
Clime	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.
Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Dw: Dwight	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Severe: erodes easily.
Ed: Edalgo	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Severe: erodes easily.
Fc: Florence	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Go: Goessel	Moderate: wetness, percs slowly, too clayey.	Moderate: wetness, too clayey, percs slowly.	Moderate: too clayey, wetness.	Moderate: too clayey.
Ib, Ic: Irwin	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight.
Kp: Kipson	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: small stones, depth to rock.	Moderate: slope.
La: Labette	Slight	Slight	Moderate: slope, small stones, depth to rock.	Slight.
Ld*:				
Labette	Slight	Slight	Moderate: slope, small stones, depth to rock.	Slight.
Dwight	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Severe: erodes easily.
Lg*:				
Labette	Slight	Slight	Moderate: slope, small stones, depth to rock.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Lg*:				
Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Lm Ladysmith	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.
Ls, Lt Lancaster	Slight	Slight	Moderate: slope.	Slight.
Lv*:				
Lancaster	Slight	Slight	Moderate: slope.	Slight.
Hedville	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, small stones, large stones.	Moderate: slope.
Os Osage	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
Pt*. Pits				
Re Reading	Severe: flooding.	Moderate: percs slowly.	Moderate: percs slowly.	Slight.
Rh Rosehill	Moderate: percs slowly, too clayey.	Moderate: too clayey, percs slowly.	Moderate: slope, too clayey, percs slowly.	Moderate: too clayey.
So Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Tu Tully	Slight	Slight	Moderate: slope, small stones.	Slight.
Vb Verdigris	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Vc Verdigris	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
Wb, Wc, Wd Wells	Slight	Slight	Moderate: slope.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Ca: Cass	Good	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Ch: Chase	Good	Good	Good	Good	Good	Good	Good	Fair	Good	Good	Fair	Good.
Cm, Cp: Clime	Fair	Fair	Good	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Cr: Clime	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
Cs*:												
Clime	Fair	Fair	Good	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Sogn	Very poor.	Very poor.	Poor	---	---	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.	Poor.
Dw: Dwight	Fair	Fair	Fair	---	---	Fair	Poor	Fair	Fair	---	Poor	Fair.
Ed: Edalgo	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Fc: Florence	Fair	Good	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Go: Goessel	Fair	Fair	Fair	---	---	Fair	Poor	Fair	Fair	---	Poor	Fair.
Ib, Ic: Irwin	Good	Good	Good	---	---	Fair	Poor	Poor	Good	---	Poor	Fair.
Kp: Kipson	Poor	Fair	Fair	---	---	Poor	Very poor.	Very poor.	Fair	---	Very poor.	Poor.
La: Labette	Fair	Good	Fair	---	---	Fair	Poor	Poor	Fair	---	Poor	Fair.
Ld*:												
Labette	Fair	Good	Fair	---	---	Fair	Poor	Poor	Fair	---	Poor	Fair.
Dwight	Fair	Fair	Fair	---	---	Fair	Poor	Fair	Fair	---	Poor	Fair.
Lg*:												
Labette	Fair	Good	Fair	---	---	Fair	Poor	Poor	Fair	---	Poor	Fair.
Sogn	Very poor.	Very poor.	Poor	---	---	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.	Poor.
Lm: Ladysmith	Fair	Good	Good	---	---	Good	Poor	Fair	Good	---	Poor	Good.
Ls, Lt: Lancaster	Fair	Good	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Lv*:												
Lancaster	Fair	Good	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Hedville	Very poor.	Poor	Poor	---	---	Poor	Very poor.	Very poor.	Poor	---	Very poor.	Poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Os------------------Osage	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	---
Pt*. Pits												
Re------------------Reading	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Rh------------------Rosehill	Fair	Good	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
So------------------Sogn	Very poor.	Very poor.	Poor	---	---	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.	Poor.
Tu------------------Tully	Good	Good	Good	---	---	Fair	Poor	Poor	Good	---	Poor	Fair.
Vb------------------Verdigris	Good	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor	Good.
Vc------------------Verdigris	Poor	Fair	Fair	Good	Good	Good	Poor	Fair	Fair	Good	Poor	Good.
Wb, Wc, Wd----------Wells	Good	Good	Good	---	---	Fair	Very poor.	Very poor.	Good	---	Very poor.	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition and does not eliminate the need for onsite investigation]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ca----------------- Cass	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Ch----------------- Chase	Severe: wetness.	Severe: flooding, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, shrink-swell.	Severe: low strength, flooding.
Cm----------------- Clime	Moderate: depth to rock, too clayey.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Cp----------------- Clime	Moderate: depth to rock, too clayey.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Cr----------------- Clime	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Cs*:					
Clime------------	Moderate: depth to rock, too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Severe: low strength.
Sogn-------------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Dw----------------- Dwight	Moderate: depth to rock, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ed----------------- Edalgo	Moderate: depth to rock, too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.
Fc----------------- Florence	Moderate: depth to rock, too clayey, large stones.	Moderate: shrink-swell, slope, large stones.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Severe: low strength.
Go----------------- Goessel	Severe: cutbanks cave, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ib, Ic------------- Irwin	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Kp----------------- Kipson	Severe: depth to rock, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.
La----------------- Labette	Severe: depth to rock.	Severe: shrink-swell.	Severe: depth to rock, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ld*:					
Labette----------	Severe: depth to rock.	Severe: shrink-swell.	Severe: depth to rock, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ld*:					
Dwight	Moderate: depth to rock, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Lg*:					
Labette	Severe: depth to rock.	Severe: shrink-swell.	Severe: depth to rock, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Lm Ladysmith	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ls Lancaster	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell.	Moderate: low strength.
Lt Lancaster	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength.
Lv*:					
Lancaster	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength.
Hedville	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.
Os Osage	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.
Pt*. Pits					
Re Reading	Moderate: too clayey.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength.
Rh Rosehill	Moderate: depth to rock, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
So Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Tu Tully	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Vb, Vc Verdigris	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Wb Wells	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Wc, Wd Wells	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition and does not eliminate the need for onsite investigation]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ca------------------ Cass	Severe: flooding.	Severe: seepage, flooding.	Severe: flooding, seepage.	Severe: flooding, seepage.	Fair: thin layer.
Ch------------------ Chase	Severe: flooding, wetness, percs slowly.	Slight-----------	Severe: flooding, too clayey.	Severe: flooding.	Poor: too clayey, hard to pack.
Cm, Cp-------------- Clime	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Cr------------------ Clime	Severe: depth to rock, percs slowly, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope, too clayey.	Severe: depth to rock, slope.	Poor: area reclaim, too clayey, hard to pack.
Cs*:					
Clime--------------	Severe: depth to rock, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Sogn---------------	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Dw------------------ Dwight	Severe: percs slowly.	Moderate: depth to rock.	Severe: depth to rock, too clayey, excess sodium.	Moderate: depth to rock.	Poor: too clayey, hard to pack, excess sodium.
Ed------------------ Edalgo	Severe: depth to rock, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Fc------------------ Florence	Severe: percs slowly.	Severe: slope.	Severe: depth to rock, too clayey.	Moderate: depth to rock, slope.	Poor: too clayey, hard to pack, small stones.
Go------------------ Goessel	Severe: wetness, percs slowly.	Slight-----------	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Ib, Ic-------------- Irwin	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.
Kp------------------ Kipson	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
La------------------ Labette	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ld*:					
Labette	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Dwight	Severe: percs slowly.	Moderate: depth to rock, slope.	Severe: depth to rock, too clayey, excess sodium.	Moderate: depth to rock.	Poor: too clayey, hard to pack, excess sodium.
Lg*:					
Labette	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Sogn	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Lm: Ladysmith	Severe: wetness, percs slowly.	Slight	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Ls, Lt: Lancaster	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Lv*:					
Lancaster	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Hedville	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
Os: Osage	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Pt*. Pits					
Re: Reading	Severe: percs slowly.	Moderate: seepage.	Moderate: flooding, too clayey.	Moderate: flooding.	Fair: too clayey, thin layer.
Rh: Rosehill	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
So: Sogn	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Tu: Tully	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Vb, Vc: Verdigris	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Wb, Wc, Wd: Wells	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition and does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ca: Cass	Good	Probable	Improbable: too sandy.	Good.
Ch: Chase	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Cm, Cp: Clime	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Cr: Clime	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
Cs*:				
Clime	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Sogn	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Dw: Dwight	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
Ed: Edalgo	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Fc: Florence	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
Go: Goessel	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Ib, Ic: Irwin	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Kp: Kipson	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
La: Labette	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Ld*:				
Labette	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Dwight	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Lg*:				
Labette	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Sogn	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Lm: Ladysmith	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Ls, Lt: Lancaster	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer.
Lv*:				
Lancaster	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer.
Hedville	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
Os: Osage	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Pt*. Pits				
Re: Reading	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Rh: Rosehill	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
So: Sogn	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Tu: Tully	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Vb, Vc: Verdigris	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Wb, Wc, Wd: Wells	Good	Improbable: excess fines.	Improbable: excess fines.	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition and does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
Ca: Cass	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, flooding.	Soil blowing	Favorable.
Ch: Chase	Slight	Severe: hard to pack.	Percs slowly, flooding, frost action.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
Cm: Clime	Moderate: depth to rock.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Cp: Clime	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Cr: Clime	Severe: slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock.	Slope, depth to rock.	Slope, depth to rock.
Cs*:						
Clime	Severe: slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Sogn	Severe: depth to rock, slope.	Slight	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Dw: Dwight	Moderate: depth to rock.	Severe: excess sodium.	Deep to water	Percs slowly, erodes easily, excess sodium.	Erodes easily, percs slowly.	Excess sodium, erodes easily, percs slowly.
Ed: Edalgo	Severe: slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock, slope.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Fc: Florence	Severe: slope.	Severe: hard to pack.	Deep to water	Large stones droughty, slope.	Slope, large stones.	Large stones, slope, droughty.
Go: Goessel	Slight	Severe: hard to pack.	Percs slowly	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Percs slowly.
Ib: Irwin	Slight	Severe: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Ic: Irwin	Moderate: slope.	Severe: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Kp: Kipson	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
La: Labette	Moderate: depth to rock.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Ld*:						
Labette	Moderate: depth to rock.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Dwight	Moderate: depth to rock.	Severe: excess sodium.	Deep to water	Percs slowly, erodes easily, excess sodium.	Erodes easily, percs slowly.	Excess sodium, erodes easily, percs slowly.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Lg*:						
Labette	Moderate: depth to rock, slope.	Severe: thin layer.	Deep to water	Percs slowly, depth to rock, slope.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Sogn	Severe: depth to rock, slope.	Slight	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Lm: Ladysmith	Slight	Severe: hard to pack.	Percs slowly	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.
Ls: Lancaster	Moderate: seepage, depth to rock.	Severe: thin layer.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
Lt: Lancaster	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Lv*:						
Lancaster	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Hedville	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock, large stones.	Slope, depth to rock, large stones.
Os: Osage	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
Pt*. Pits						
Re: Reading	Moderate: seepage.	Slight	Deep to water	Favorable	Erodes easily	Erodes easily.
Rh: Rosehill	Moderate: depth to rock.	Severe: hard to pack.	Deep to water	Slow intake, percs slowly, depth to rock.	Depth to rock, percs slowly.	Depth to rock, percs slowly.
So: Sogn	Severe: depth to rock.	Slight	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Tu: Tully	Moderate: slope.	Moderate: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Vb, Vc: Verdigris	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding	Favorable	Favorable.
Wb: Wells	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Favorable	Favorable	Favorable.
Wc, Wd: Wells	Moderate: seepage, slope.	Moderate: thin layer, piping.	Deep to water	Slope	Favorable	Favorable.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments >3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ca---------------- Cass	0-18	Fine sandy loam	SM, SM-SC	A-4, A-2	0	100	95-100	85-95	20-40	<20	NP-5
	18-60	Fine sandy loam, sandy loam, very fine sandy loam.	SM, SM-SC	A-4, A-2	0	100	95-100	85-95	20-50	<20	NP-5
Ch---------------- Chase	0-12	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	15-25
	12-60	Silty clay, silty clay loam, clay.	CH, CL	A-7, A-6	0	100	100	95-100	90-100	35-65	20-45
Cm, Cp----------- Clime	0-10	Silty clay loam	CL	A-6, A-7-6	0-5	90-100	90-100	85-100	80-95	35-50	15-25
	10-30	Silty clay, clay, silty clay loam.	CH, CL	A-7, A-6	0	95-100	95-100	95-100	85-95	35-60	15-35
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Cr---------------- Clime	0-7	Stony silty clay loam.	CL, CH	A-7	5-15	90-100	90-100	85-100	80-95	40-60	20-30
	7-23	Silty clay, clay, silty clay loam.	CH, CL	A-7, A-6	0	95-100	95-100	95-100	85-95	35-60	15-35
	23	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Cs*:											
Clime-----------	0-7	Silty clay loam	CL	A-6, A-7-6	0-5	90-100	90-100	85-100	80-95	35-50	15-25
	7-27	Silty clay, clay, silty clay loam.	CH, CL	A-7 A-6	0	95-100	05-100	95-100	85-95	35-60	15-35
	27	Unweathered bedrock.									
Sogn------------	0-8	Silty clay loam	CL, MH, CH	A-6, A-7	0-10	85-100	85-100	85-100	70-100	25-55	10-25
	8	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Dw---------------- Dwight	0-6	Silt loam--------	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-15
	6-56	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	56	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ed---------------- Edalgo	0-10	Silty clay loam	CL	A-6, A-7	0	95-100	85-100	75-100	60-95	30-45	10-25
	10-34	Silty clay loam, silty clay, clay.	CL, CH	A-7	0	95-100	85-100	75-100	65-95	45-70	20-40
	34	Weathered bedrock	---	---	---	---	---	---	---	---	---
Fc---------------- Florence	0-13	Silt loam--------	CL	A-6	0-5	90-100	75-100	75-95	70-95	25-35	10-20
	13-16	Very cherty silty clay, cherty silty clay loam.	GC, SC	A-2-7, A-7	10-20	30-70	20-45	20-45	15-40	50-65	30-40
	16-45	Coarse cherty clay, cherty clay, very cherty clay.	GC, SC, CH	A-2-7, A-7	10-40	30-90	20-80	20-75	15-70	50-75	30-45
	45	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Go------------- Goessel	0-13	Silty clay-------	CH	A-7-6	0	100	100	95-100	85-95	50-70	30-45
	13-42	Silty clay, clay	CH	A-7-6	0	100	100	95-100	85-95	50-75	30-50
	42-60	Silty clay, clay, clay loam.	CH, CL	A-7-6	0	100	100	90-100	70-95	40-65	20-40
Ib, Ic----------- Irwin	0-13	Silty clay loam	CL, ML	A-6, A-7-6	0	100	95-100	90-100	80-95	35-50	10-25
	13-40	Silty clay, clay	CH	A-7-6	0	100	95-100	95-100	85-95	50-70	25-45
	40-60	Silty clay, clay, silty clay loam.	CH, CL	A-7-6	0	100	100	95-100	80-95	40-65	20-45
Kp--------------- Kipson	0-9	Silty clay loam	CL, ML, MH, CH	A-2 , A-7	0-25	80-100	70-100	65-100	60-95	35-55	10-20
	9-20	Shaly silty clay loam, silt loam, silty clay loam.	CL-ML, CL	A-6, A-4	0-25	70-100	60-100	55-100	50-95	25-40	5-20
	20	Weathered bedrock	---	---	---	---	---	---	---	---	---
La--------------- Labette	0-8	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	85-100	30-50	10-25
	8-36	Silty clay, silty clay loam, cherty silty clay.	CH, CL	A-7-6	0-20	75-100	70-100	65-100	60-100	40-60	20-35
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ld*:											
Labette---------	0-7	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	85-100	30-50	10-25
	7-36	Silty clay, silty clay loam, cherty silty clay.	CH, CL	A-7-6	0-20	75-100	70-100	65-100	60-100	40-60	20-35
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Dwight----------	0-6	Silt loam--------	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-15
	6-56	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	56	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Lg*:											
Labette---------	0-7	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	85-100	30-50	10-25
	7-36	Silty clay, silty clay loam, cherty silty clay.	CH, CL	A-7-6	0-20	75-100	70-100	65-100	60-100	40-60	20-35
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Sogn------------	0-10	Silty clay loam	CL, MH, CH	A-6, A-7	0-10	85-100	85-100	85-100	70-100	25-55	10-25
	10	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Lm--------------- Ladysmith	0-9	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	30-45	15-25
	9-52	Silty clay, clay	CH	A-7-6	0	100	100	95-100	85-95	50-70	30-50
	52-60	Silty clay, silty clay loam, clay.	CL, CH	A-7-6	0	100	100	95-100	85-95	40-65	25-45
Ls, Lt----------- Lancaster	0-7	Loam------------	CL-ML, CL	A-4, A-6	0	100	100	85-100	50-85	20-35	5-15
	7-25	Sandy clay loam, clay loam, loam.	CL, SC	A-4, A-6, A-7-6	0	100	100	80-95	40-65	25-45	8-25
	25-35	Clay loam, loam, sandy clay loam.	CL-ML, SC, SM-SC, CL	A-4, A-6	0	100	100	80-100	36-80	20-35	5-15
	35	Weathered bedrock	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
Lv*:											
Lancaster--------	0-7	Loam-------------	CL-ML, CL	A-4, A-6	0	100	100	85-100	50-85	20-35	5-15
	7-25	Sandy clay loam, clay loam, loam.	CL, SC	A-4, A-6, A-7-6	0	100	100	80-95	40-65	25-45	8-25
	25-35	Clay loam, loam, sandy clay loam.	CL-ML, SC, SM-SC, CL	A-4, A-6	0	100	100	80-100	36-80	20-35	5-15
	35	Weathered bedrock	---	---	---	---	---	---	---	---	---
Hedville---------	0-10	Stony loam--------	SM, ML SC, CL	A-4, A-6	15-25	70-100	70-100	50-85	35-70	<35	NP-13
	10-17	Loam-------------	SM, ML, SC, CL	A-4, A-6	0-15	70-100	70-100	50-85	35-70	<35	NP-13
	17	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Os--------------- Osage	0-21	Silty clay--------	CH	A-7	0	100	100	100	95-100	50-75	30-55
	21-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	100	95-100	40-80	20-50
Pt*. Pits											
Re--------------- Reading	0-6	Silt loam---------	CL, CL-ML	A-4, A-6	0	100	100	90-100	85-100	25-40	5-20
	6-60	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	15-30
Rh--------------- Rosehill	0-8	Silty clay--------	CH	A-7	0	100	100	90-100	75-95	50-70	30-50
	8-28	Silty clay, clay	CH	A-7	0	100	100	90-100	75-95	50-70	30-50
	28	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
So--------------- Sogn	0-8	Silty clay loam	CL, MH, CH	A-6, A-7	0-10	85-100	85-100	85-100	70-100	25-55	10-25
	8	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Tu--------------- Tully	0-17	Silty clay loam	CL, ML	A-6, A-7	0	100	75-100	75-100	70-95	35-50	10-25
	17-60	Silty clay, clay, cherty silty clay.	CH, CL	A-7	0	90-100	70-100	65-100	55-95	40-65	20-40
Vb, Vc----------- Verdigris	0-22	Silt loam---------	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	65-100	22-38	2-13
	22-60	Silt loam, silty clay loam.	CL	A-4, A-6, A-7	0	100	100	95-100	80-100	30-45	8-23
Wb, Wc----------- Wells	0-15	Loam-------------	CL-ML, CL	A-4, A-6	0	100	100	95-100	65-85	20-30	5-15
	15-36	Clay loam, sandy clay loam.	SC, CL	A-4, A-6, A-7	0	100	100	80-100	40-85	30-50	8-25
	36-60	Clay loam, sandy clay loam, sandy loam.	SC, CL, ML, SM	A-4, A-6	0	100	100	80-100	35-85	20-40	NP-15
Wd--------------- Wells	0-9	Clay loam---------	CL	A-6, A-7	0	100	100	90-100	70-80	35-50	15-30
	9-36	Clay loam, sandy clay loam.	SC, CL	A-4, A-6, A-7	0	100	100	80-100	40-85	30-50	8-25
	36-60	Clay loam, sandy clay loam, sandy loam.	SC, CL, ML, SM	A-4, A-6	0	100	100	80-100	35-85	20-40	NP-15

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
Ca	0-18	7-17	1.40-1.60	2.0-6.0	0.16-0.18	5.6-7.3	<2	Low	0.20	5	3	1-4
Cass	18-60	5-15	1.40-1.60	2.0-6.0	0.15-0.17	6.1-8.4	<2	Low	0.20			
Ch	0-12	27-35	1.30-1.45	0.2-0.6	0.21-0.23	5.6-7.3	<2	Moderate	0.37	5	7	2-4
Chase	12-60	35-55	1.35-1.45	0.06-0.2	0.11-0.19	5.6-7.8	<2	High	0.28			
Cm, Cp	0-10	32-40	1.35-1.45	0.2-0.6	0.21-0.23	6.6-8.4	<2	Moderate	0.37	3	4L	2-4
Clime	10-30	35-60	1.35-1.50	0.06-0.2	0.12-0.18	7.4-8.4	2	Moderate	0.28			
	30	---	---	---	---	---	---	---	---			
Cr	0-7	35-50	1.35-1.45	0.06-0.6	0.10-0.18	6.6-8.4	<2	Moderate	0.20	3	8	1-4
Clime	7-23	35-60	1.35-1.50	0.06-0.2	0.12-0.18	7.4-8.4	<2	Moderate	0.28			
	23	---	---	---	---	---	---	---	---			
Cs*:												
Clime	0-7	32-40	1.35-1.45	0.2-0.6	0.21-0.23	6.6-8.4	<2	Moderate	0.37	3	4L	2-4
	7-27	35-60	1.35-1.50	0.06-0.2	0.12-0.18	7.4-8.4	<2	Moderate	0.28			
	27	---	---	---	---	---	---	---	---			
Sogn	0-8	27-35	1.15-1.20	0.6-2.0	0.17-0.22	6.1-8.4	<2	Moderate	0.32	1	4L	2-4
	8	---	---	---	---	---	---	---	---			
Dw	0-6	18-30	1.20-1.35	0.6-2.0	0.21-0.24	5.6-7.3	<2	Low	0.43	3	6	2-4
Dwight	6-56	45-60	1.30-1.40	<0.06	0.10-0.14	6.1-8.4	<4	High	0.32			
	56	---	---	---	---	---	---	---	---			
Ed	0-10	28-37	1.30-1.40	0.06-0.6	0.15-0.22	5.6-7.3	<2	Moderate	0.37	3	7	2-4
Edalgo	10-34	35-60	1.35-1.50	<0.06	0.10-0.18	5.6-7.3	<2	High	0.37			
	34	---	---	---	---	---	---	---	---			
Fc	0-13	24-35	1.25-1.35	0.6-2.0	0.18-0.24	5.6-7.3	<2	Low	0.32	3	7	2-4
Florence	13-16	35-55	1.35-1.55	0.2-0.6	0.03-0.11	5.6-7.3	<2	Moderate	0.24			
	16-45	50-80	1.35-1.60	0.2-0.6	0.03-0.12	6.1-7.8	<2	Moderate	0.24			
	45	---	---	---	---	---	---	---	---			
Go	0-13	40-55	1.30-1.40	<0.06	0.12-0.16	6.1-7.3	<2	High	0.28	5	4	1-4
Goessel	13-42	40-55	1.35-1.45	<0.06	0.10-0.15	7.4-8.4	<2	High	0.28			
	42-60	30-50	1.40-1.55	<0.06	0.09-0.14	7.9-8.4	<2	High	0.28			
Ib, Ic	0-13	28-35	1.35-1.45	0.2-0.6	0.18-0.23	5.6-7.3	<2	Moderate	0.37	4	7	2-4
Irwin	13-40	40-55	1.40-1.50	<0.06	0.10-0.15	5.6-8.4	<2	High	0.37			
	40-60	35-55	1.40-1.50	<0.2	0.09-0.15	6.6-8.4	<2	High	0.37			
Kp	0-9	27-35	1.30-1.40	0.6-2.0	0.17-0.20	7.4-8.4	<2	Moderate	0.32	2	4L	2-4
Kipson	9-20	18-35	1.35-1.50	0.6-2.0	0.15-0.20	7.9-9.0	<2	Moderate	0.32			
	20	---	---	---	---	---	---	---	---			
La	0-8	28-35	1.35-1.45	0.2-0.6	0.21-0.23	5.6-6.5	<2	Moderate	0.37	3	7	2-4
Labette	8-36	35-50	1.40-1.50	0.06-0.2	0.12-0.19	5.6-8.4	<2	High	0.37			
	36	---	---	---	---	---	---	---	---			
Ld*:												
Labette	0-7	28-35	1.35-1.45	0.2-0.6	0.21-0.23	5.6-6.5	<2	Moderate	0.37	3	7	2-4
	7-36	35-50	1.40-1.50	0.06-0.2	0.12-0.19	5.6-8.4	<2	High	0.37			
	36	---	---	---	---	---	---	---	---			
Dwight	0-6	18-30	1.20-1.35	0.6-2.0	0.21-0.24	5.6-7.3	<2	Low	0.43	3	6	2-4
	6-56	45-60	1.30-1.40	<0.06	0.10-0.14	6.1-8.4	<4	High	0.32			
	56	---	---	---	---	---	---	---	---			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--*Continued*

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
Lg*:												
Labette	0-7	28-35	1.35-1.45	0.2-0.6	0.21-0.23	5.6-6.5	<2	Moderate	0.37	3	7	2-4
	7-36	35-50	1.40-1.50	0.06-0.2	0.12-0.19	5.6-8.4	<2	High	0.37			
	36	---	---	---	---	---	---	---	---			
Sogn	0-10	27-35	1.15-1.20	0.6-2.0	0.17-0.22	6.1-8.4	<2	Moderate	0.32	1	4L	2-4
	10	---	---	---	---	---	---	---	---			
Lm Ladysmith	0-9	28-35	1.35-1.45	0.2-0.6	0.21-0.23	5.6-7.3	<2	Moderate	0.37	4	7	2-4
	9-52	40-60	1.35-1.50	<0.06	0.10-0.15	5.6-7.8	<2	High	0.37			
	52-60	35-55	1.40-1.60	0.06-0.6	0.10-0.19	7.4-8.4	<2	Moderate	0.37			
Ls, Lt Lancaster	0-7	12-26	1.35-1.45	0.6-2.0	0.17-0.22	5.6-6.5	<2	Low	0.28	4	6	2-6
	7-25	18-35	1.35-1.50	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28			
	25-35	12-26	1.40-1.55	0.6-2.0	0.15-0.19	6.1-7.3	<2	Low	0.28			
	35	---	---	---	---	---	---	---	---			
Lv*:												
Lancaster	0-7	12-26	1.35-1.45	0.6-2.0	0.17-0.22	5.6-6.5	<2	Low	0.28	4	6	2-6
	7-25	18-35	1.35-1.50	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28			
	25-35	12-26	1.40-1.55	0.6-2.0	0.15-0.19	6.1-7.3	<2	Low	0.28			
	35	---	---	---	---	---	---	---	---			
Hedville	0-10	8-22	1.35-1.50	0.6-2.0	0.09-0.14	5.6-7.3	<2	Low	0.24	2	8	1-4
	10-17	8-22	1.35-1.50	0.6-2.0	0.14-0.20	5.6-7.3	<2	Low	0.32			
	17	---	---	---	---	---	---	---	---			
Os Osage	0-21	40-50	1.40-1.60	<0.06	0.12-0.14	5.1-7.8	<2	Very high	0.28	5	4	1-4
	21-60	35-60	1.50-1.70	<0.06	0.08-0.12	5.6-7.8	<2	Very high	0.28			
Pt*. Pits												
Re Reading	0-6	18-27	1.35-1.40	0.6-2.0	0.22-0.24	5.6-7.3	<2	Low	0.32	5	6	2-4
	6-60	27-35	1.40-1.50	0.2-2.0	0.18-0.20	5.6-7.3	<2	Moderate	0.43			
Rh Rosehill	0-8	40-60	1.20-1.35	<0.06	0.11-0.14	6.1-7.3	<2	High	0.28	3	4	1-3
	8-28	40-60	1.30-1.45	<0.06	0.10-0.14	6.6-8.4	<2	High	0.28			
	28	---	---	---	---	---	---	---	---			
So Sogn	0-8	27-35	1.15-1.20	0.6-2.0	0.17-0.22	6.1-8.4	<2	Moderate	0.32	1	4L	2-4
	8	---	---	---	---	---	---	---	---			
Tu Tully	0-17	28-38	1.35-1.45	0.2-2.0	0.18-0.23	5.6-7.3	<2	Moderate	0.37	4	7	2-4
	17-60	35-55	1.40-1.50	0.06-0.2	0.10-0.15	5.6-7.8	<2	High	0.37			
Vb, Vc Verdigris	0-22	15-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	<2	Low	0.32	5	6	2-4
	22-60	18-35	1.40-1.65	0.6-2.0	0.17-0.22	5.6-7.3	<2	Moderate	0.32			
Wb, Wc Wells	0-15	18-24	1.35-1.50	0.6-2.0	0.20-0.22	5.6-6.5	<2	Low	0.28	5	5	1-4
	15-36	25-35	1.35-1.50	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28			
	36-60	10-30	1.35-1.60	0.6-2.0	0.12-0.18	6.1-7.8	<2	Low	0.28			
Wd Wells	0-9	27-32	1.40-1.60	0.2-0.6	0.17-0.20	5.6-6.5	<2	Moderate	0.28	5	6	1-3
	9-36	25-35	1.35-1.50	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28			
	36-60	18-30	1.35-1.50	0.6-2.0	0.12-0.18	6.1-7.8	<2	Low	0.28			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	Uncoated steel	Concrete
					Ft			In			
Ca-----------------Cass	B	Occasional	Brief------	Mar-Jun	>6.0	---	---	>60	---	Moderate	Low.
Ch-----------------Chase	C	Occasional	Very brief	Mar-Sep	2.0-4.0	Perched	Feb-May	>60	---	High------	Low.
Cm, Cp, Cr---------Clime	C	None---------	---	---	>6.0	---	---	20-40	Soft	High------	Low.
Cs*:											
Clime-------------	C	None---------	---	---	>6.0	---	---	20-40	Soft	High------	Low.
Sogn--------------	D	None---------	---	---	>6.0	---	---	4-20	Hard	Low-------	Low.
Dw-----------------Dwight	D	None---------	---	---	>6.0	---	---	40-60	Hard	High------	Moderate.
Ed-----------------Edalgo	C	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	Low.
Fc-----------------Florence	C	None---------	---	---	>6.0	---	---	40-60	Hard	Moderate	Low.
Go-----------------Goessel	D	None---------	---	---	2.0-3.0	Perched	Apr-Jun	>60	---	High------	Low.
Ib, Ic-------------Irwin	D	None---------	---	---	>6.0	---	---	>60	---	High------	Low.
Kp-----------------Kipson	D	None---------	---	---	>6.0	---	---	7-20	Soft	Low-------	Low.
La-----------------Labette	C	None---------	---	---	>6.0	---	---	20-40	Hard	High------	Low.
Ld*:											
Labette-----------	C	None---------	---	---	>6.0	---	---	20-40	Hard	High------	Low.
Dwight------------	D	None---------	---	---	>6.0	---	---	40-60	Hard	High------	Moderate.
Lg*:											
Labette-----------	C	None---------	---	---	>6.0	---	---	20-40	Hard	High------	Low.
Sogn--------------	D	None---------	---	---	>6.0	---	---	4-20	Hard	Low-------	Low.
Lm-----------------Ladysmith	D	None---------	---	---	2.0-3.0	Perched	Apr-Jun	>60	---	High------	Low.
Ls, Lt-------------Lancaster	B	None---------	---	---	>6.0	---	---	20-40	Soft	Low-------	Moderate.
Lv*:											
Lancaster---------	B	None---------	---	---	>6.0	---	---	20-40	Soft	Low-------	Moderate.
Hedville----------	D	None---------	---	---	>6.0	---	---	4-20	Hard	Low-------	Moderate.
Os-----------------Osage	D	Occasional	Very brief to long.	Nov-May	0-1.0	Apparent	Nov-May	>60	---	High------	Moderate.
Pt*. Pits											
Re-----------------Reading	B	Rare---------	---	---	>6.0	---	---	>60	---	Moderate	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hard-ness	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In			
Rh: Rosehill	D	None	---	---	>6.0	---	---	20-40	Soft	High	Low.
So: Sogn	D	None	---	---	>6.0	---	---	4-20	Hard	Low	Low.
Tu: Tully	C	None	---	---	>6.0	---	---	>60	---	High	Low.
Vb: Verdigris	B	Occasional	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low	Low.
Vc: Verdigris	B	Frequent	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low	Low.
Wb, Wc, Wd: Wells	B	None	---	---	>6.0	---	---	>60	---	Low	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution							Liquid limit	Plasticity index	Moisture density	
			Percentage passing sieve--				Percentage smaller than--						
	AASHTO	Unified	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			Max. dry density	Optimum moisture
										Pct		Lb/ft3	Pct
Sogn sicl:[1] (S79KS-115-001)													
A1--------0 to 9	A-7-5(25)	MH	100	100	99	98	62	33	24	51	21	88	24
Tully sicl:[2] (S79KS-115-002)													
A1--------0 to 12	A-7-6(28)	CH	100	100	100	99	67	36	26	52	24	91	24
B22t-----25 to 36	A-7-6(43)	CH	100	100	100	98	69	37	22	63	38	98	22
C---------42 to 60	A-7-6(33)	CH	100	100	99	95	71	39	21	53	31	103	21

[1]Sogn silty clay loam:
2,240 ft S. and 100 ft W. of the NE. corner, sec. 29, T. 18 S., R. 5 E.

[2]Tully silty clay loam:
1,560 ft W. and 650 ft N. of the SE. corner, sec. 35, T. 18 S., R. 4 E.

TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Cass	Coarse-loamy, mixed, mesic Fluventic Haplustolls
Chase	Fine, montmorillonitic, mesic Aquic Argiudolls
Clime	Fine, mixed, mesic Udorthentic Haplustolls
Dwight	Fine, montmorillonitic, mesic Typic Natrustolls
Edalgo	Fine, mixed, mesic Udic Argiustolls
Florence	Clayey-skeletal, montmorillonitic, mesic Udic Argiustolls
Goessel	Fine, montmorillonitic, mesic Udic Pellusterts
Hedville	Loamy, mixed, mesic Lithic Haplustolls
Irwin	Fine, mixed, mesic Pachic Argiustolls
Kipson	Loamy, mixed, mesic, shallow Udorthentic Haplustolls
Labette	Fine, mixed, mesic Udic Argiustolls
Ladysmith	Fine, montmorillonitic, mesic Pachic Argiustolls
Lancaster	Fine-loamy, mixed, mesic Udic Argiustolls
*Osage	Fine, montmorillonitic, thermic Vertic Haplaquolls
Reading	Fine-silty, mixed, mesic Typic Argiudolls
Rosehill	Fine, montmorillonitic, mesic Udertic Haplustolls
Sogn	Loamy, mixed, mesic Lithic Haplustolls
Tully	Fine, mixed, mesic Pachic Argiustolls
*Verdigris	Fine-silty, mixed, thermic Cumulic Hapludolls
Wells	Fine-loamy, mixed, mesic Udic Argiustolls

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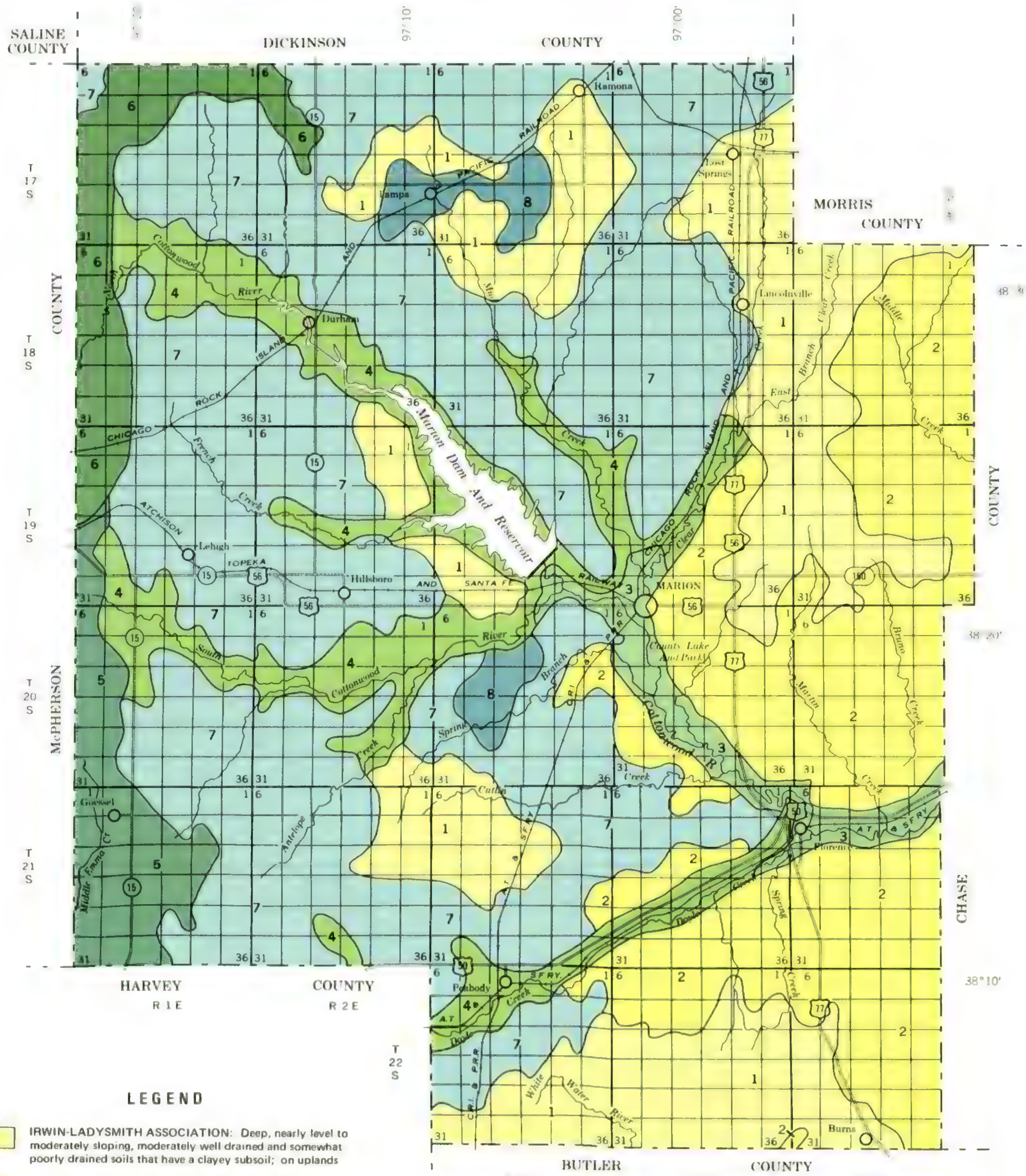


LEGEND

1 — IRWIN-LADYSMITH ASSOCIATION: Deep, nearly level to moderately sloping, moderately well drained and somewhat poorly drained soils that have a clayey subsoil; on uplands

2 — LABETTE-TULLY-SOGN ASSOCIATION: Deep to shallow nearly level to strongly sloping, well drained and somewhat excessively drained soils that have a clayey or silty subsoil; on uplands

3 — VERDIGRIS-CHASE-READING ASSOCIATION: Deep, nearly level, moderately well drained, somewhat poorly drained, and well drained soils that have a silty or clayey subsoil; on flood plains and stream terraces

4 — WELLS-VERDIGRIS ASSOCIATION: Deep, nearly level to moderately sloping, well drained and moderately well drained soils that have a loamy or silty subsoil; on uplands and flood plains

5 — LADYSMITH-GOESSEL ASSOCIATION: Deep, nearly level, somewhat poorly drained and moderately well drained soils that have a clayey subsoil; on uplands

6 — LANCASTER-HEDVILLE ASSOCIATION: Moderately deep and shallow, gently sloping to strongly sloping, well drained and somewhat excessively drained soils that have a loamy subsoil; on uplands

7 — IRWIN-CLIME ASSOCIATION: Deep and moderately deep, gently sloping to moderately steep, moderately well drained and well drained soils that have a clayey or silty subsoil; on uplands

8 — GOESSEL-ROSEHILL ASSOCIATION: Deep and moderately deep, nearly level and gently sloping, moderately well drained soils that have a clayey subsoil; on uplands

Compiled 1983

N

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

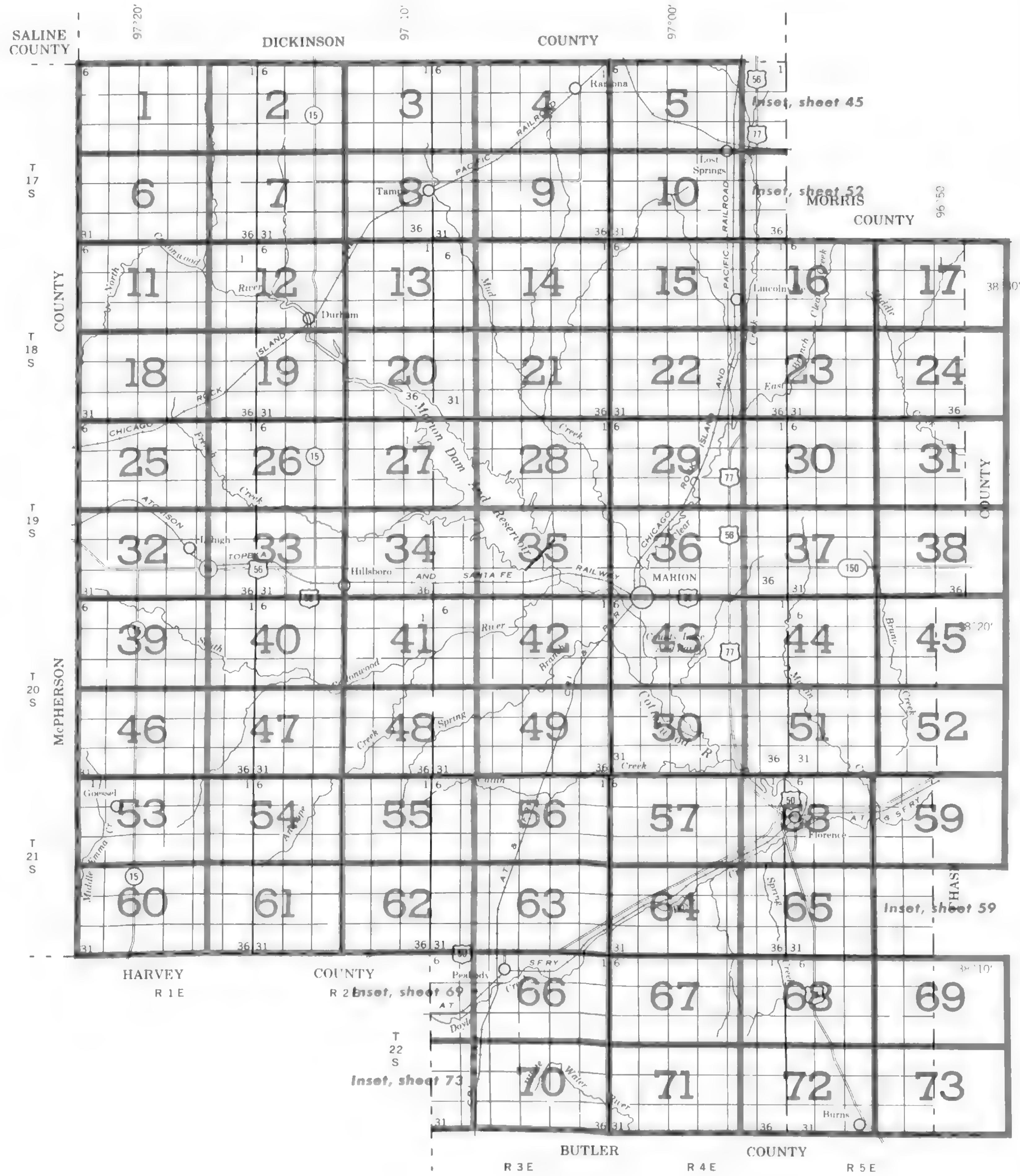
GENERAL SOIL MAP

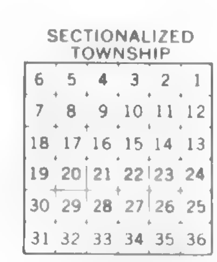
MARION COUNTY, KANSAS

Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 4 8 Km





Original text from each individual map sheet read:
This map is compiled on 1978 aerial photography by U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

INDEX TO MAP SHEETS
MARION COUNTY, KANSAS

Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 4 8 Km

SOIL LEGEND

SYMBOL	NAME
Ca	Cass fine sandy loam
Ch	Chase silty clay loam
Cm	Clime silty clay loam, 1 to 3 percent slopes
Cp	Clime silty clay loam, 3 to 7 percent slopes
Cr	Clime stony silty clay loam, 15 to 30 percent slopes
Cs	Clime-Sogn silty clay loams, 3 to 20 percent slopes
Dw	Dwight silt loam, 0 to 2 percent slopes
Ed	Edalgo silty clay loam, 3 to 12 percent slopes
Fc	Florence silt loam, 2 to 15 percent slopes
Go	Goessel silty clay
Ib	Irwin silty clay loam, 1 to 3 percent slopes
Ic	Irwin silty clay loam, 3 to 6 percent slopes
Kp	Kipson silty clay loam, 10 to 25 percent slopes
La	Labette silty clay loam, 1 to 4 percent slopes
Ld	Labette-Dwight complex, 1 to 3 percent slopes
Lg	Labette-Sogn silty clay loams, 2 to 15 percent slopes
Lm	Ladysmith silty clay loam, 0 to 2 percent slopes
Ls	Lancaster loam, 1 to 3 percent slopes
Lt	Lancaster loam, 3 to 7 percent slopes
Lv	Lancaster-Hedville complex, 3 to 20 percent slopes
Os	Osage silty clay
Pt	Pits, quarries
Re	Reading silt loam
Rh	Rosehill silty clay, 1 to 3 percent slopes
So	Sogn silty clay loam, 0 to 15 percent slopes
Tu	Tully silty clay loam, 2 to 6 percent slopes
Vb	Verdigris silt loam
Vc	Verdigris silt loam, channeled
Wb	Wells loam, 1 to 3 percent slopes
Wc	Wells loam, 3 to 7 percent slopes
Wd	Wells clay loam, 3 to 7 percent slopes, eroded

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label) — Hedley Airstrip

- Small airport, airfield, park, oilfield, cemetery, or flood pool — FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate — 21
- Federal — 173
- State — 79
- County, farm or ranch — 1283

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water, w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — Gas
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water, w
- Intermittent — int, i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — CnB, WaC

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

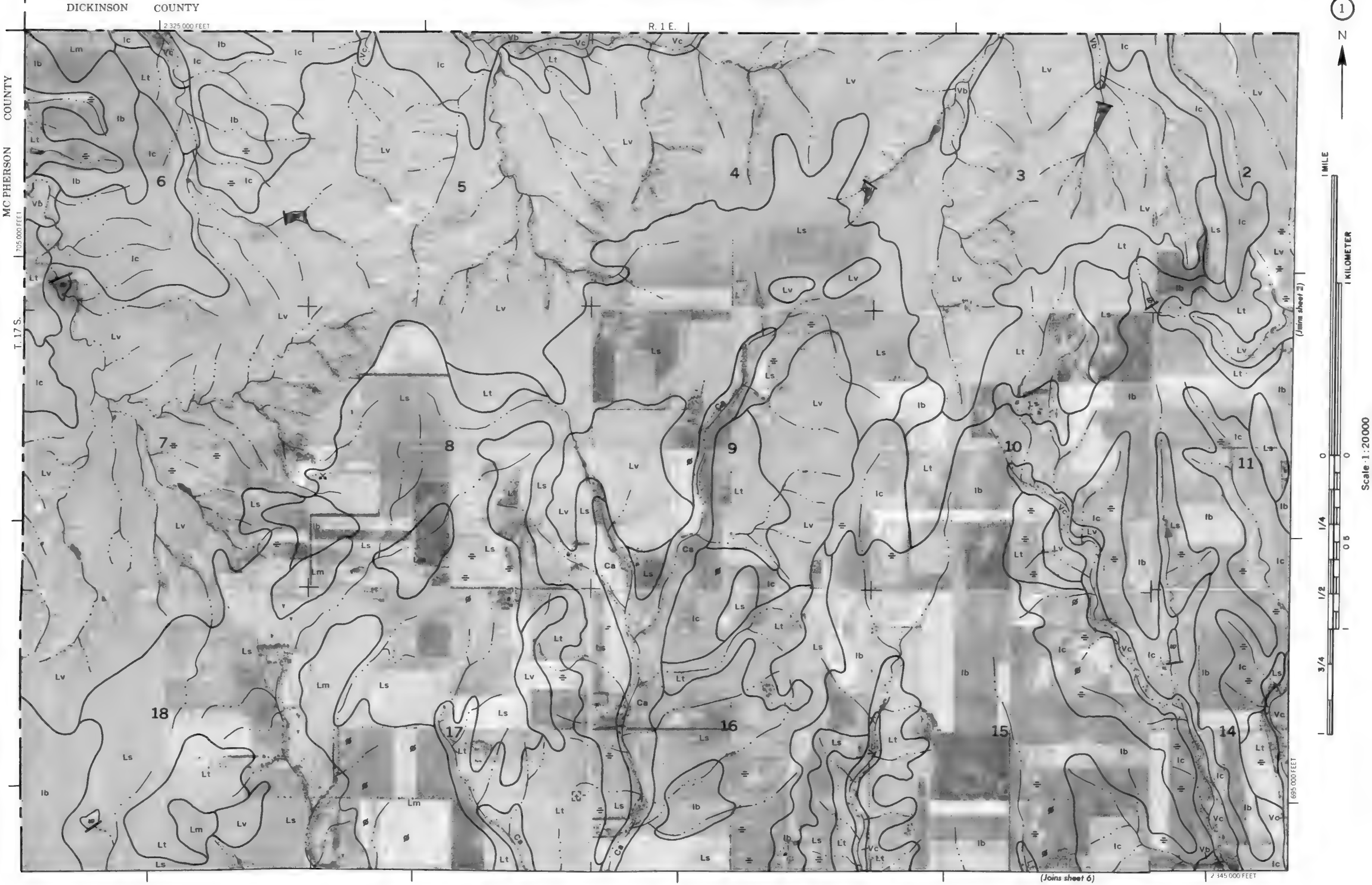
GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot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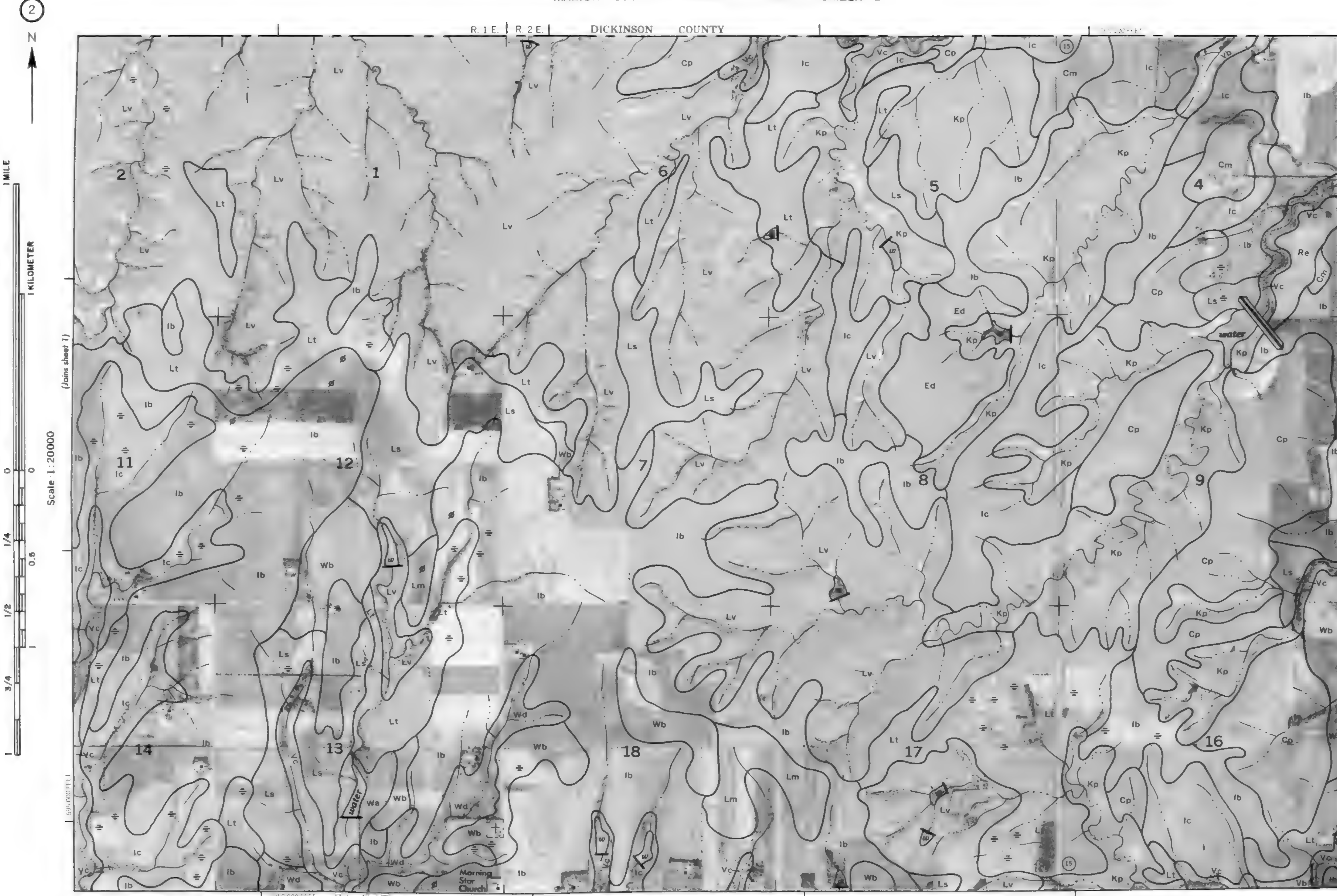
DICKINSON COUNTY
MC PHERSON COUNTY
2 325 000 FEET
R. 1 E.
705 000 FEET
T. 17 S.
(Joins sheet 2)
695 000 FEET
(Joins sheet 6)
2 345 000 FEET
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:20000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1 MILE
1 KILOMETER
Scale 1:20000
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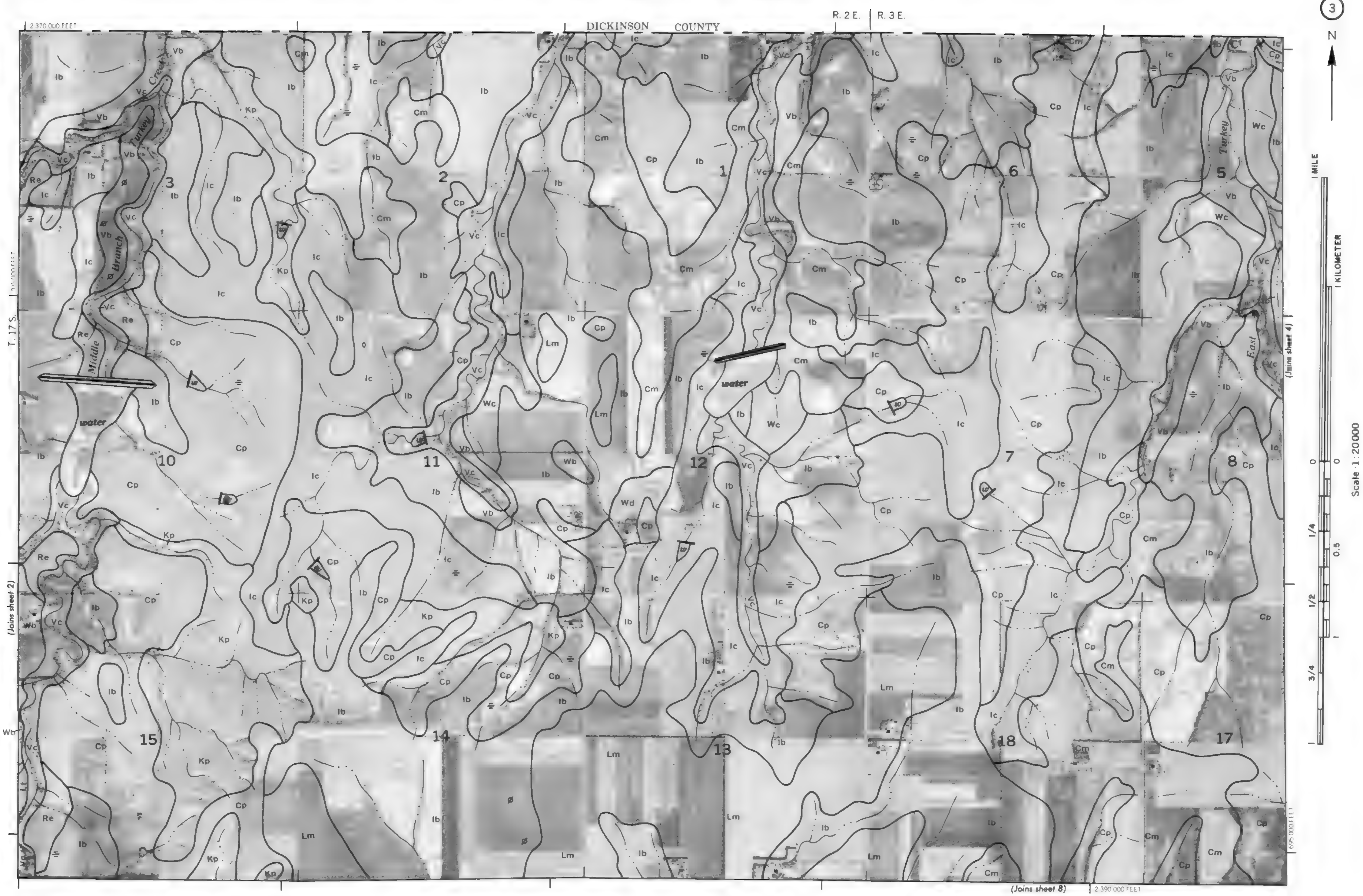
1/4
1/2
3/4
1
0
0.5
1
R. 1 E.
R. 2 E.
DICKINSON COUNTY
T. 17 S.
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 7)
Morning Star Church
water
2 350 000 FEET
705 000 FEET
695 000 FEET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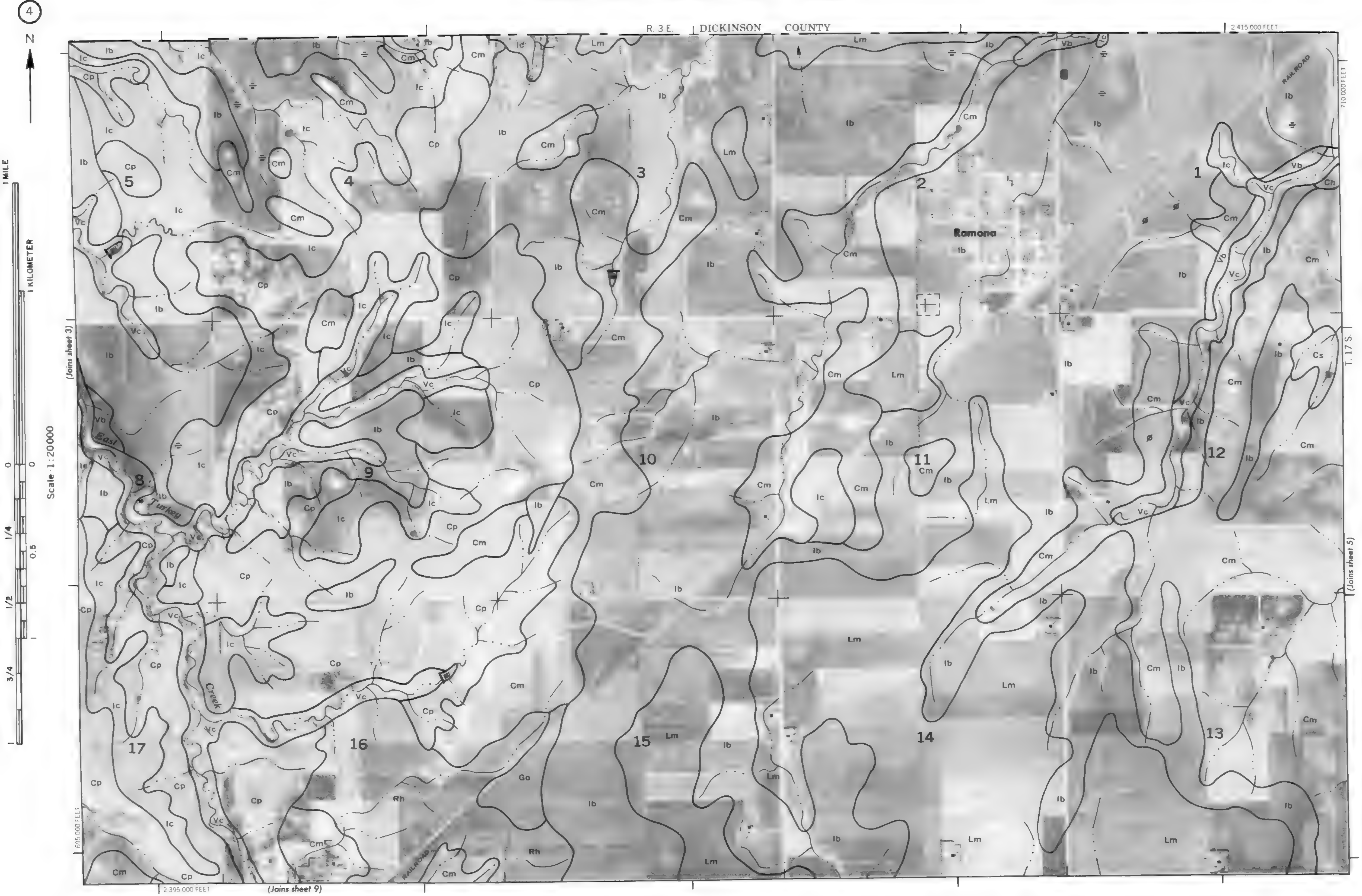
N
DICKINSON COUNTY
R. 2 E.
R. 3 E.
2 370 000 FEET
T. 17 S.
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 8)
2 390 000 FEET
695 000 FEET
Middle Branch Turkey Creek
East Turkey
water
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18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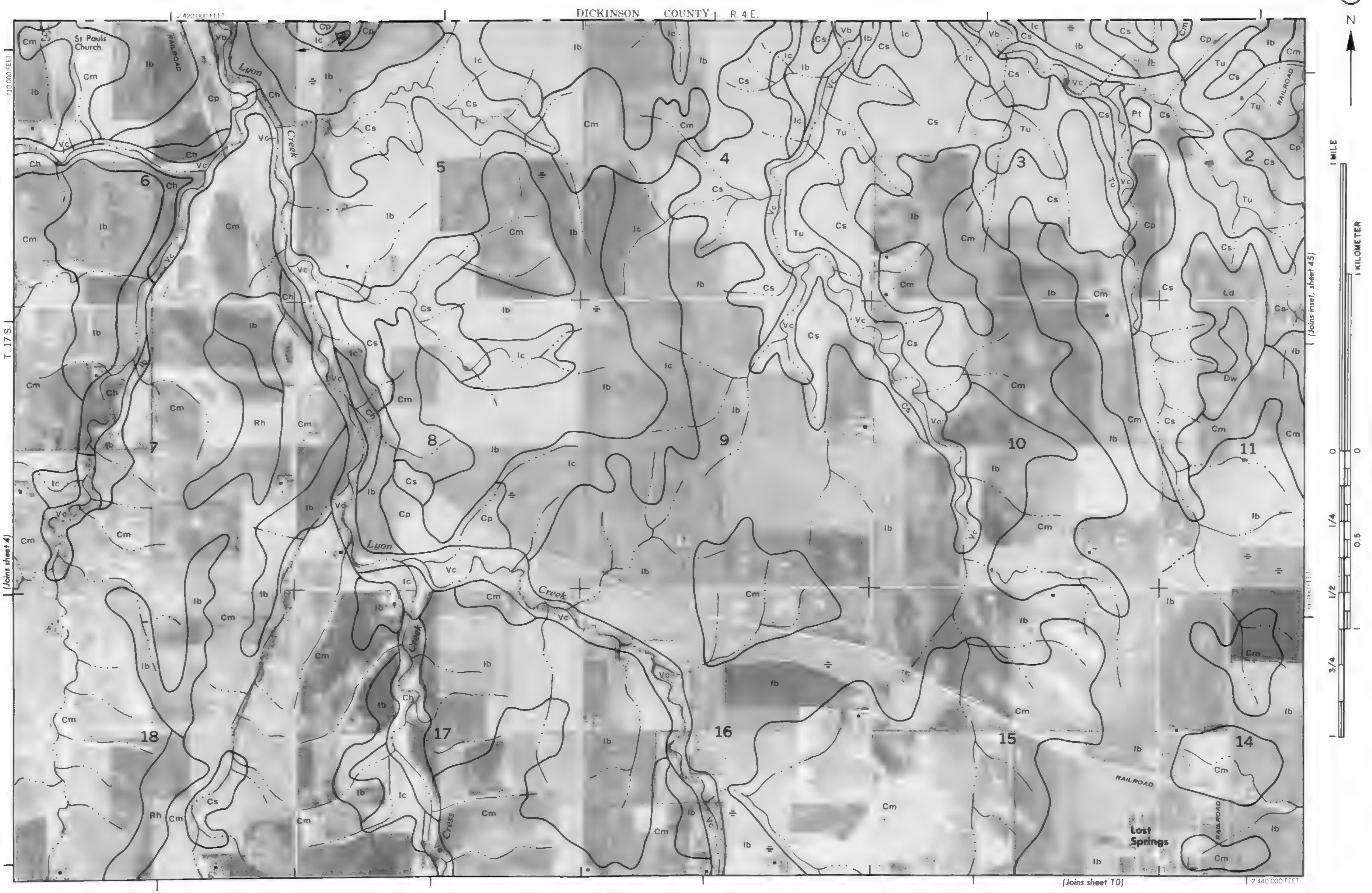
N
R. 3 E.
DICKINSON COUNTY
2 415 000 FEET
710 000 FEET
T. 17 S.
(Joins sheet 3)
(Joins sheet 5)
(Joins sheet 9)
2 395 000 FEET
695 000 FEET
Ramona
RAILROAD
East
Turkey
Creek
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
0.5
1/2
3/4
1


5
DICKINSON COUNTY
R. 4 E.
2 420 000 FEET
710 000 FEET
T. 17 S.
St Pauls Church
RAILROAD
Lyon Creek
Cress Creek
Lost Springs
(Joins sheet 4)
(Joins inset, sheet 45)
(Joins sheet 10)
2 440 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
2
3
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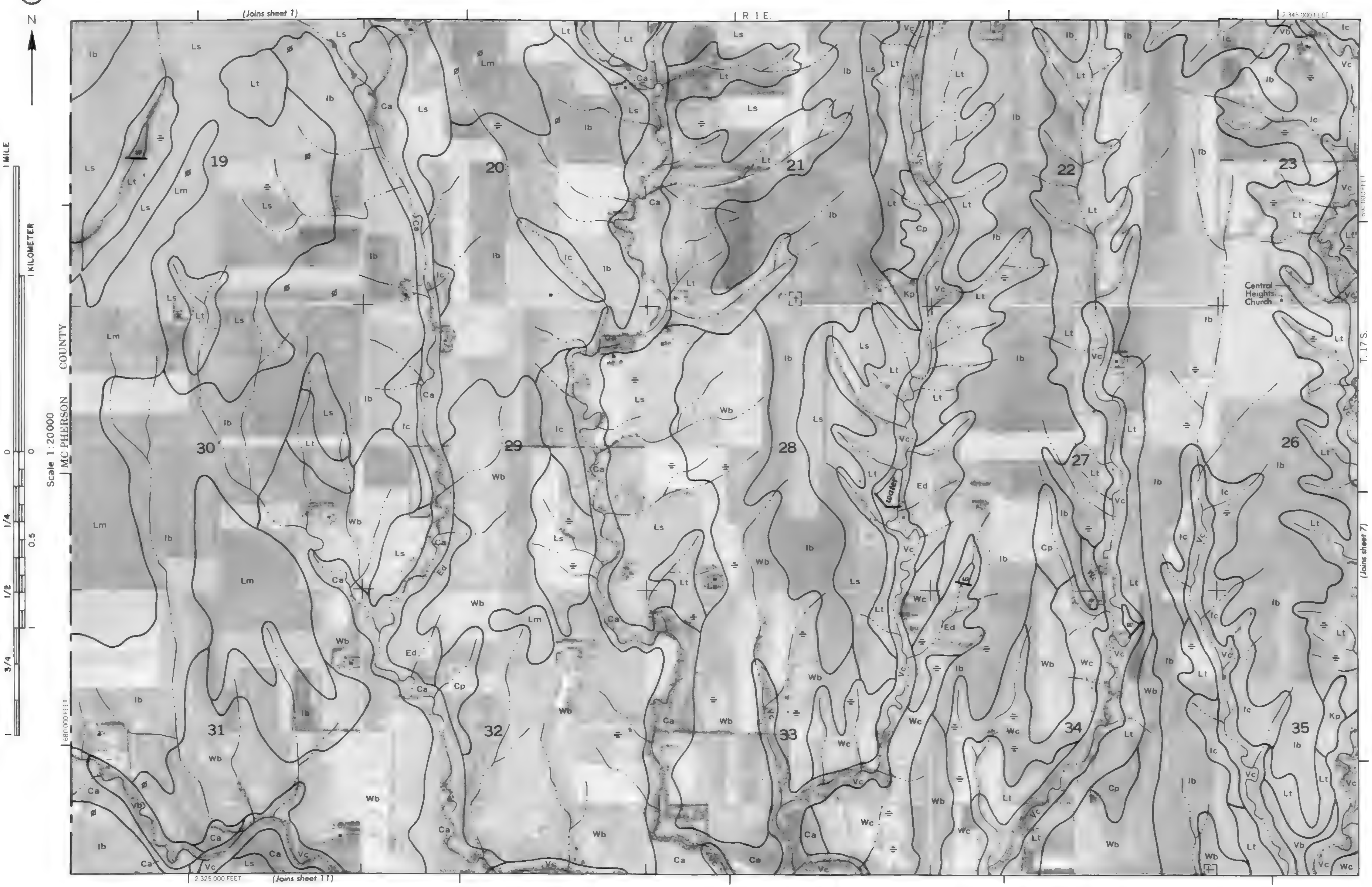
16
17
18

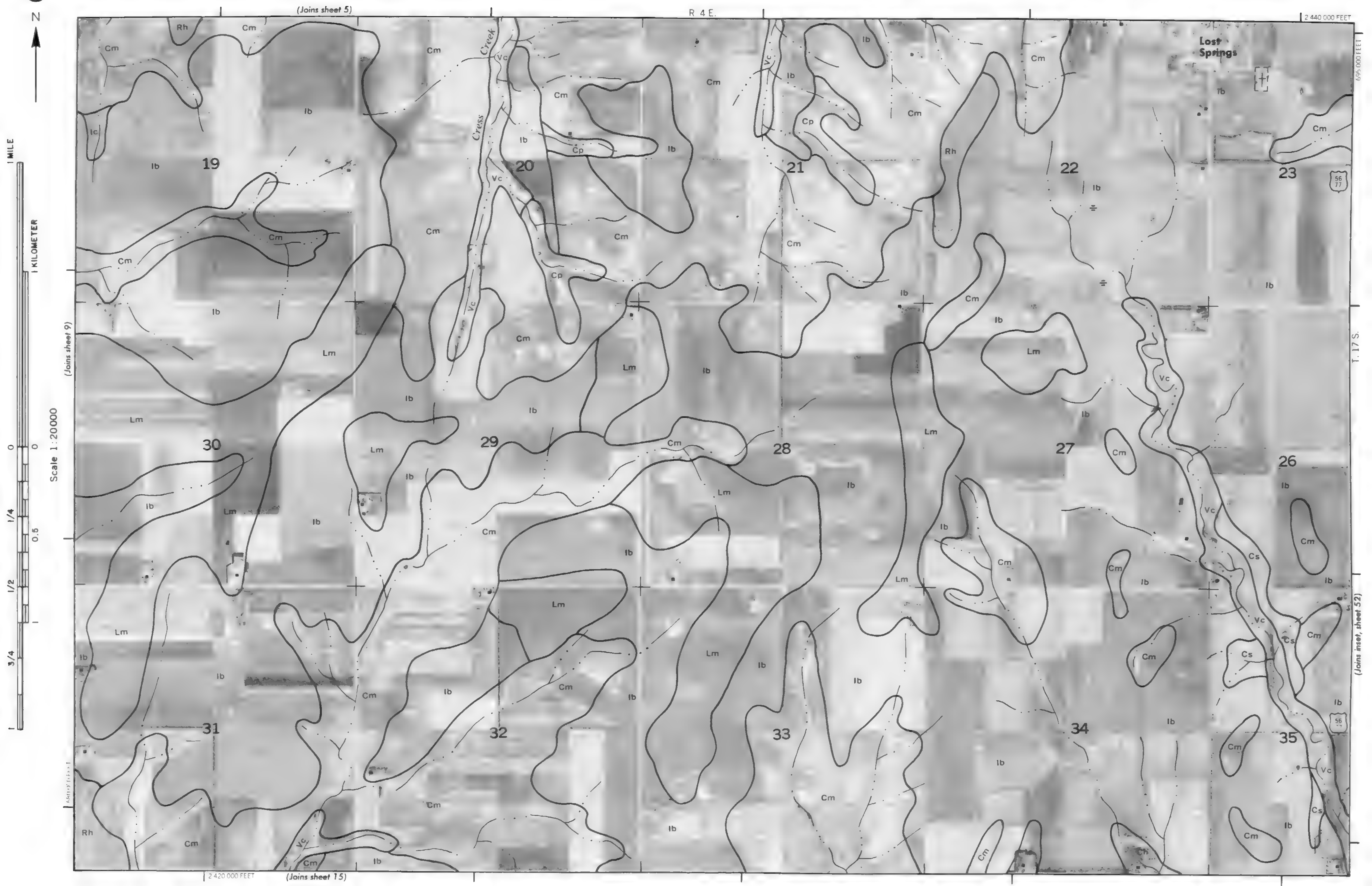
6


N
(Joins sheet 1)
R 1 E.
2 345 000 FEET
(Joins sheet 7)
T. 17 S.
(Joins sheet 11)
2 325 000 FEET
680 000 FEET
MC PHERSON COUNTY
Scale 1:20000
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Central Heights Church
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
water


R. 1 E.
R. 2 E.
T. 17 S.
(Joins sheet 2)
(Joins sheet 8)
(Joins sheet 6)
(Joins sheet 12)
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5
2 370 000 FEET
680 000 FEET
water
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36


8
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 3)
(Joins sheet 7)
(Joins sheet 9)
(Joins sheet 13)
R. 2 E.
R. 3 E.
T. 17 S.
2 390 000 FEET
690 000 FEET
680 000 FEET
RAILROAD
Mud Creek
Tampa
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36
Ib
Cp
Kp
Vc
Lm
Wb
Go
Cm
Rh
Ic
Re

MARION COUNTY, KANSAS — SHEET NUMBER 9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1 KILOMETER
Scale 1:20000
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1/4
1/2
3/4
1
0
0.5
1
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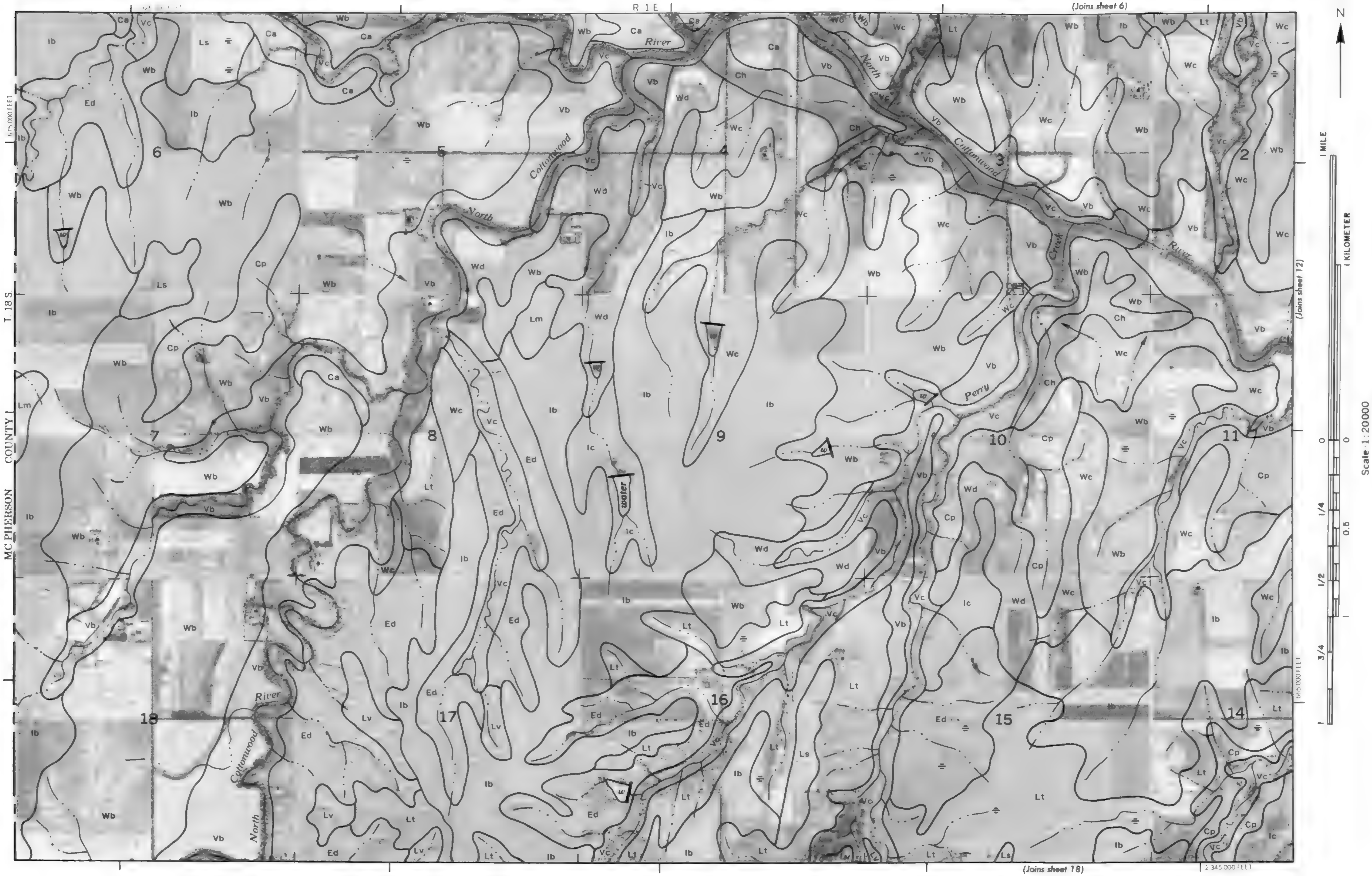
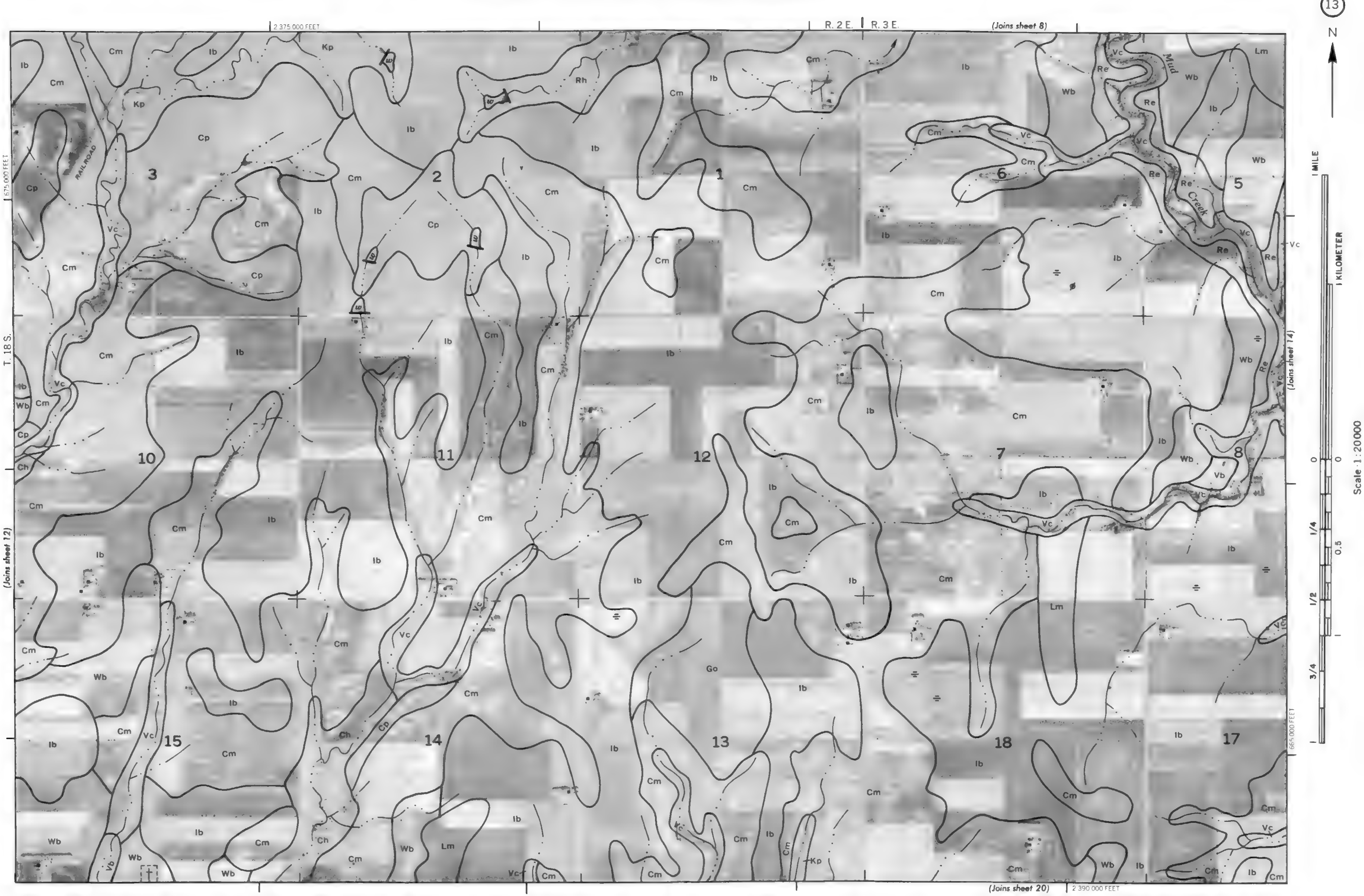
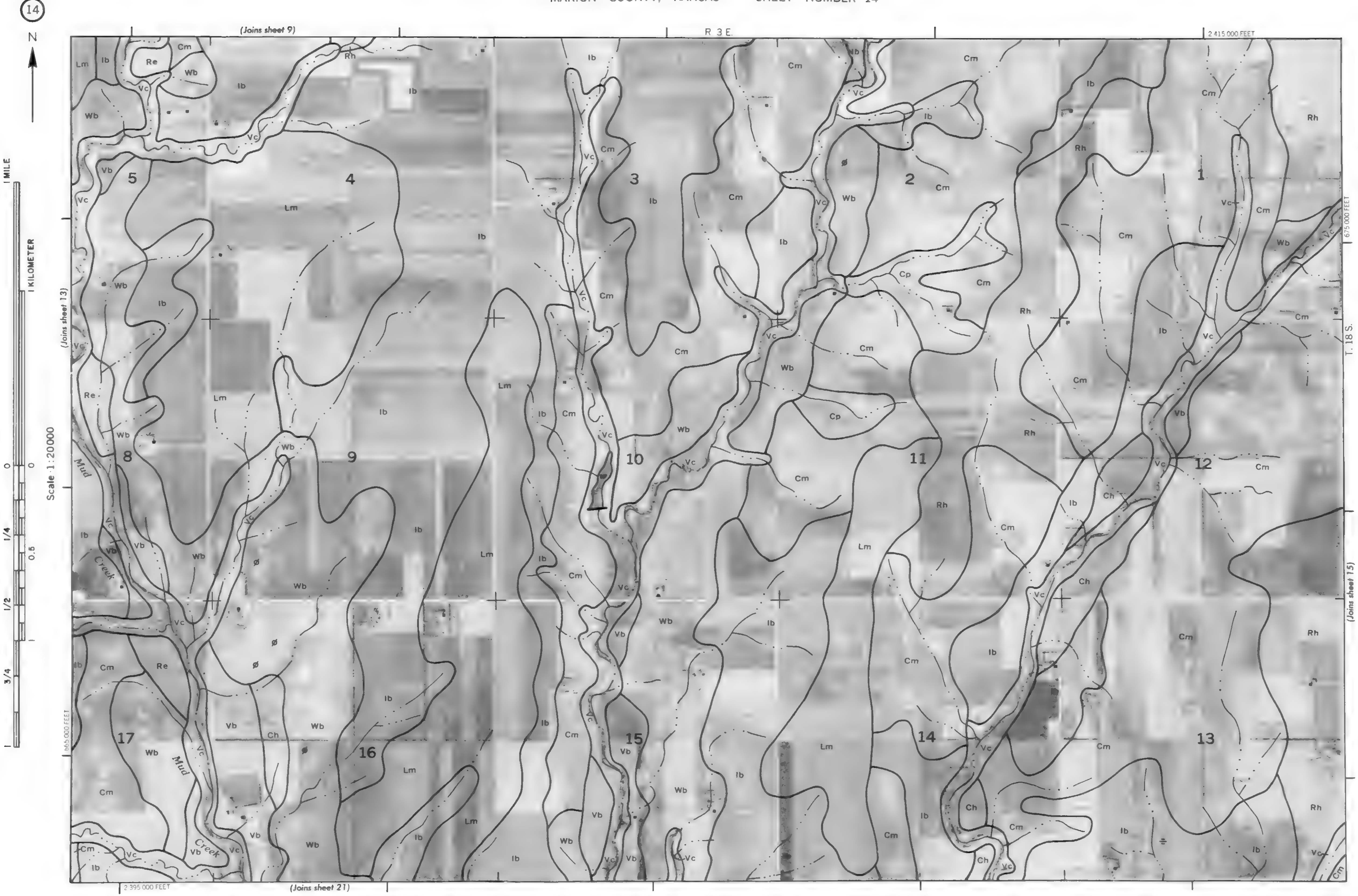
R. 4 E.
2 440 000 FEET
(Joins sheet 9)
T. 17 S.
(Joins inset, sheet 52)
2 420 000 FEET
(Joins sheet 15)
Lost Springs
Cress
Creek
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
56
77
Cm
Ib
Ic
Rh
Vc
Cp
Lm
Cs

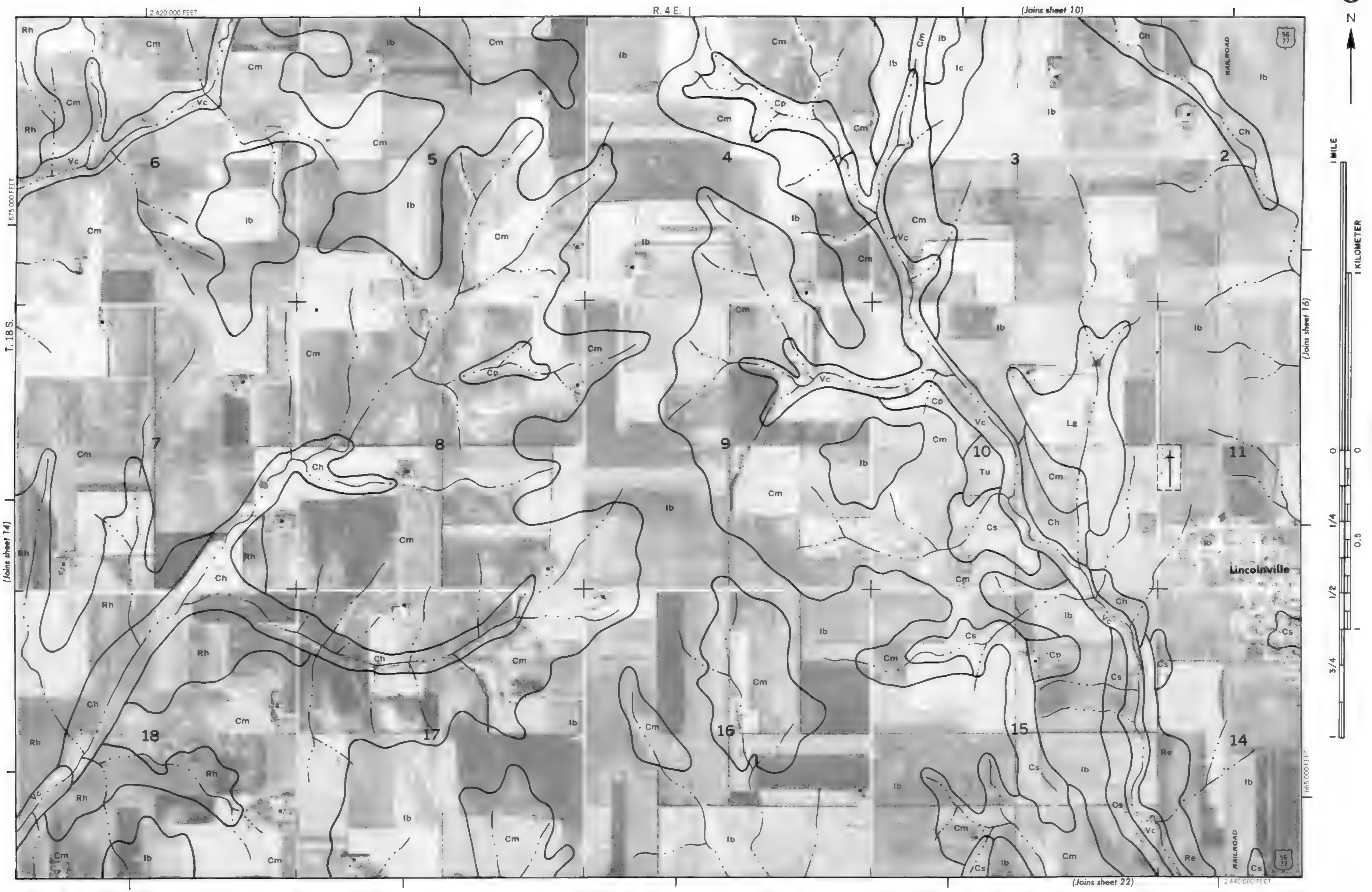

11
N
R 1 E
(Joins sheet 6)
(Joins sheet 12)
(Joins sheet 18)
T. 18 S.
MC PHERSON COUNTY
North Cottonwood River
Perry Creek
water
1 MILE
1 KILOMETER
Scale 1:20000
675 000 FEET
665 000 FEET
2 345 000 FEET


12
N
(Joins sheet 7)
R. 1 E.
R. 2 E.
(Joins sheet 11)
(Joins sheet 13)
(Joins sheet 19)
T. 18 S.
1 MILE
1 KILOMETER
Scale 1:20000
North Cottonwood River
RAILROAD
Durham
15

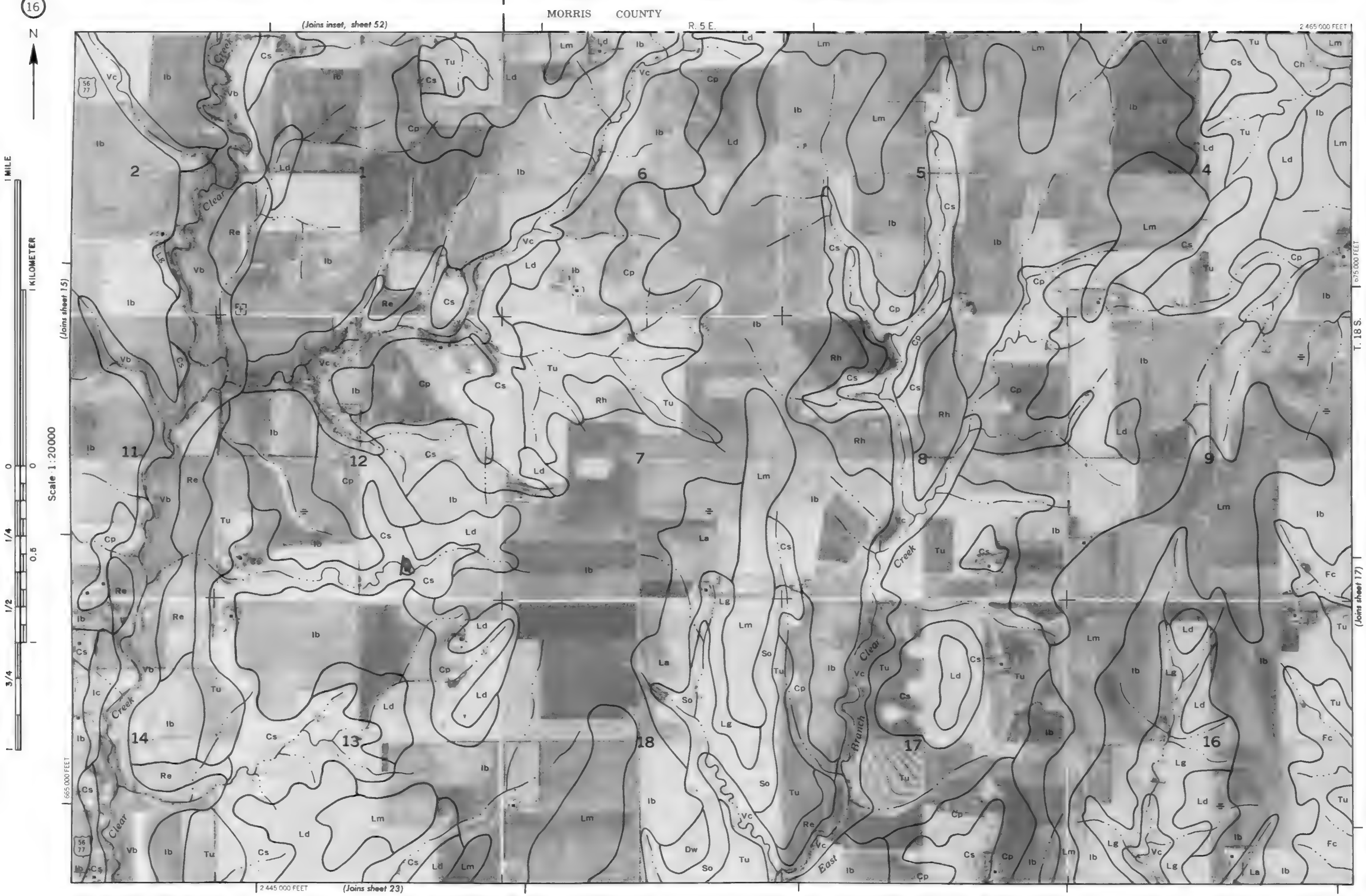

13
N
2 375 000 FEET
R. 2 E. | R. 3 E.
(Joins sheet 8)
675 000 FEET
T. 18 S.
(Joins sheet 12)
(Joins sheet 14)
665 000 FEET
(Joins sheet 20)
2 390 000 FEET
RAILROAD
Mud Creek
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18


14
N
(Joins sheet 9)
R 3 E.
2 415 000 FEET
675 000 FEET
T. 18 S.
(Joins sheet 15)
(Joins sheet 21)
2 395 000 FEET
665 000 FEET
(Joins sheet 13)
Scale 1:20000
1 MILE
1 KILOMETER
Mud Creek

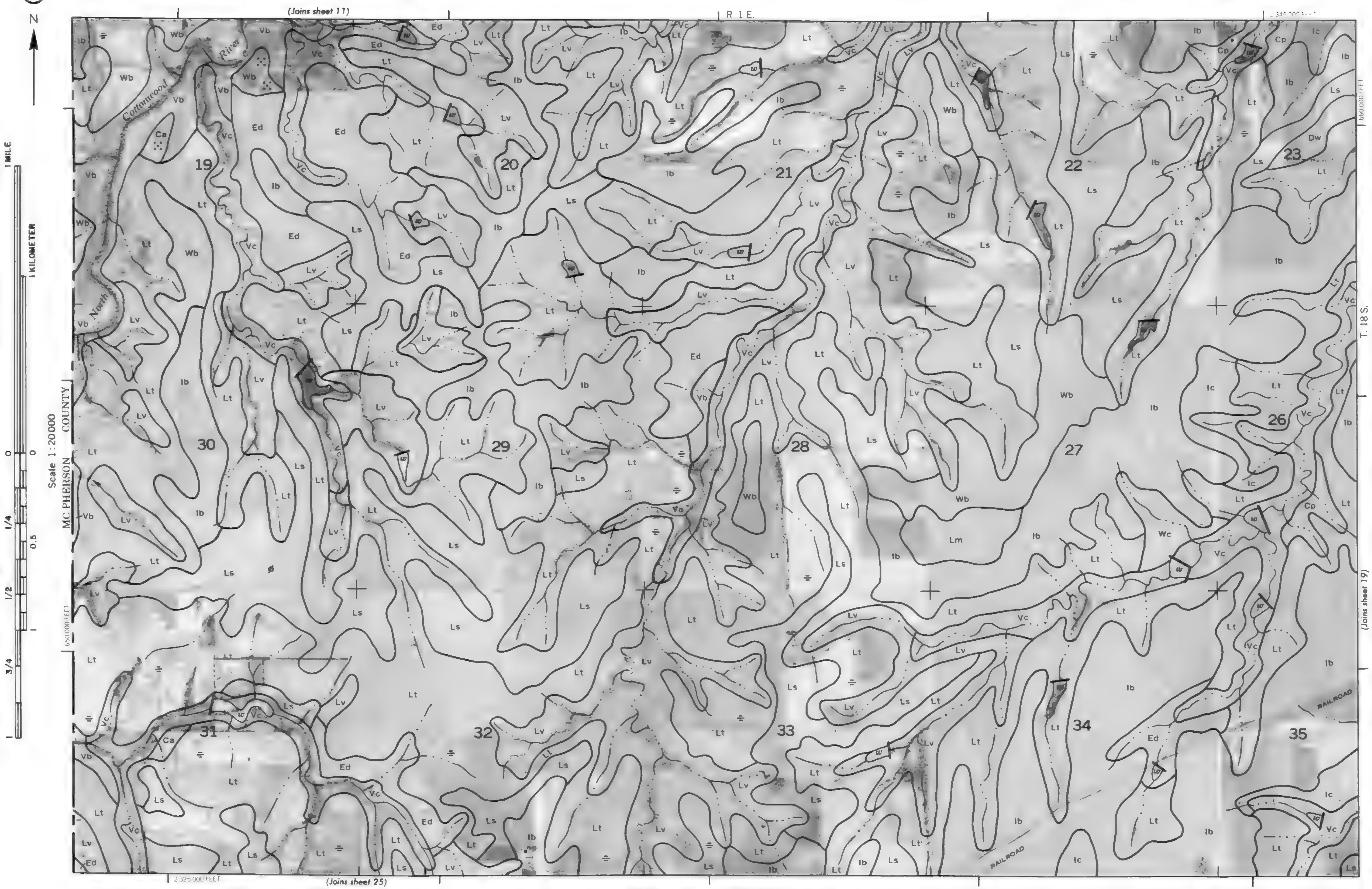
MARION COUNTY, KANSAS — SHEET NUMBER 15



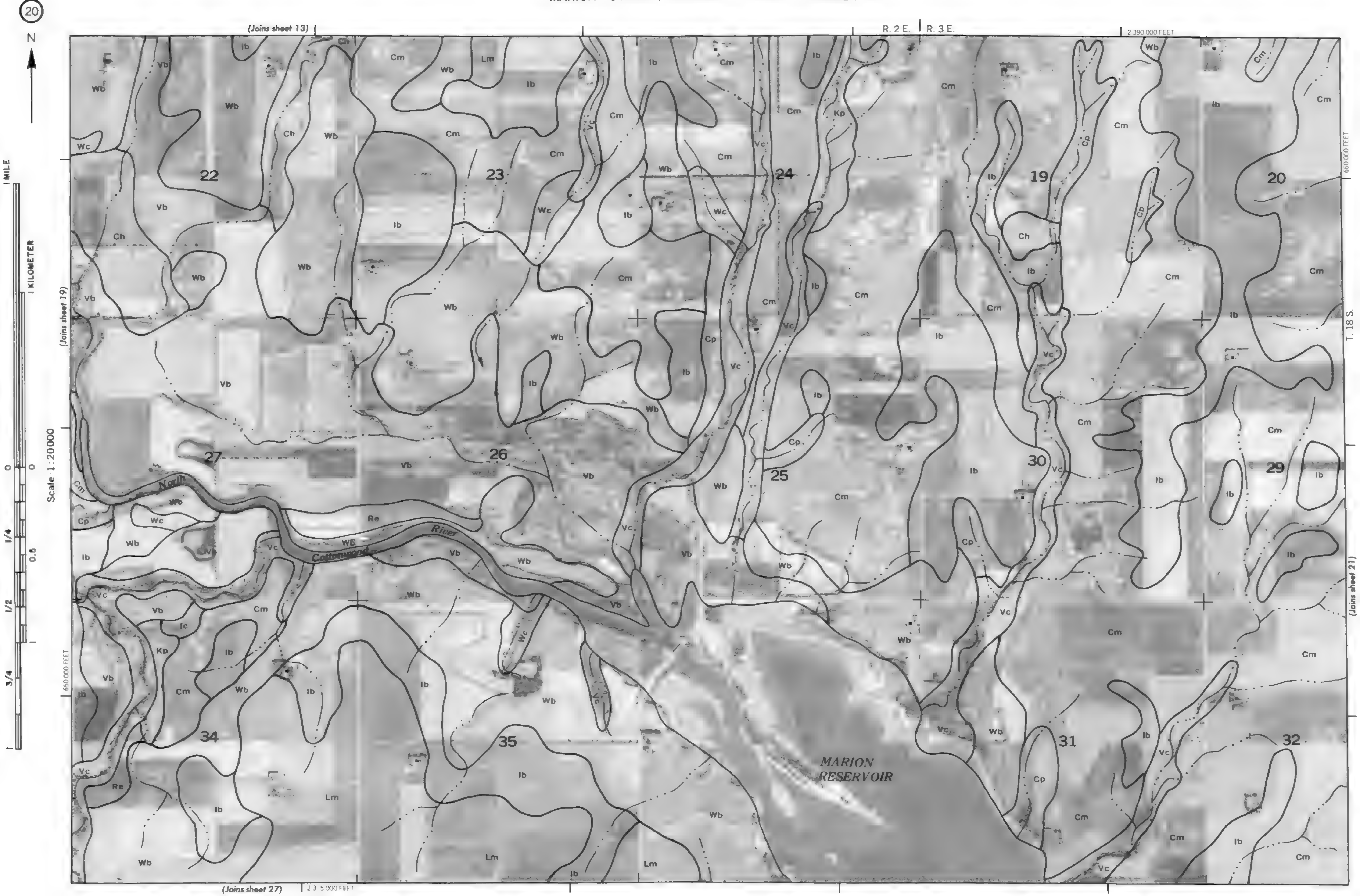
MARION COUNTY, KANSAS — SHEET NUMBER 16

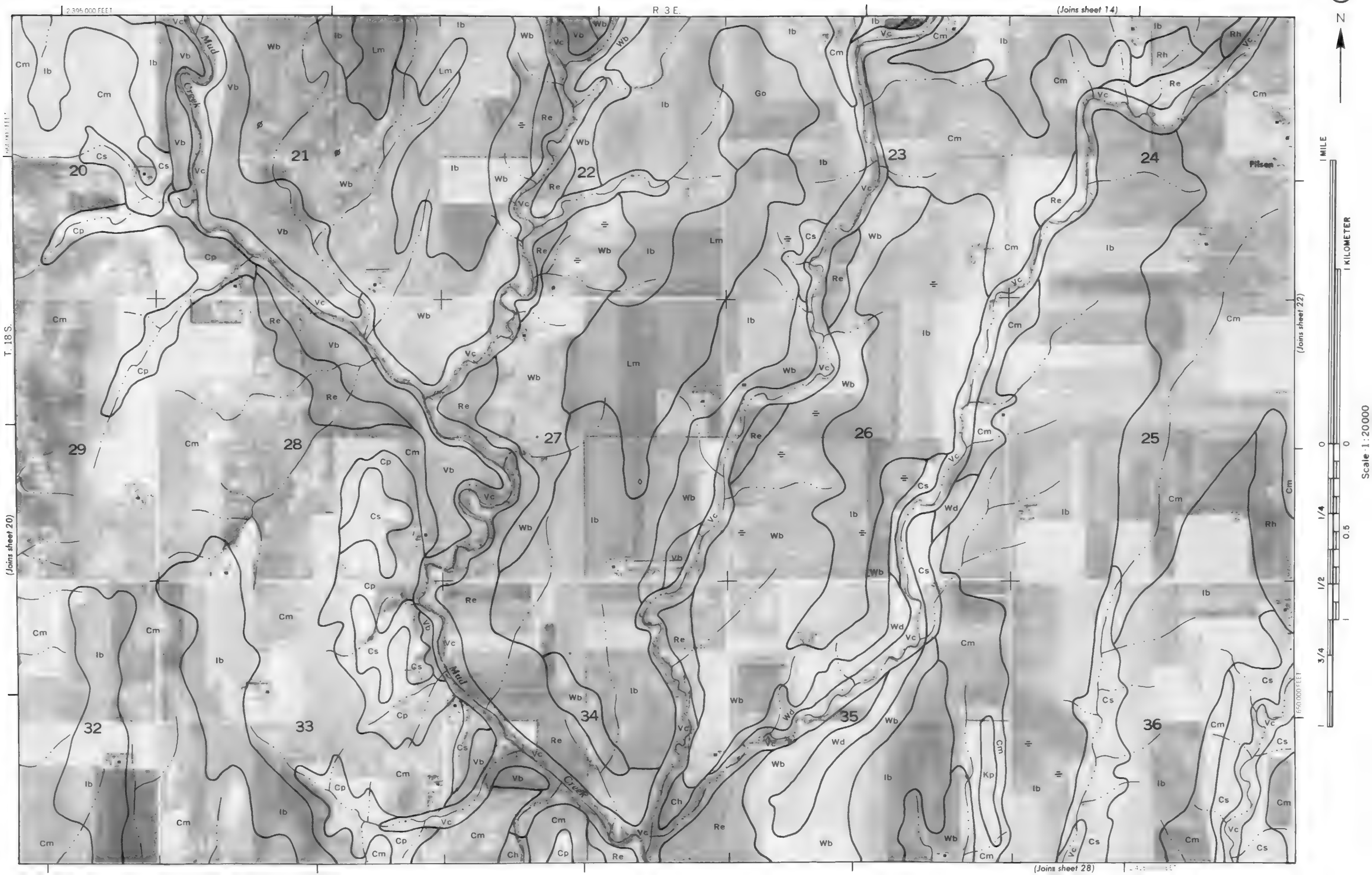


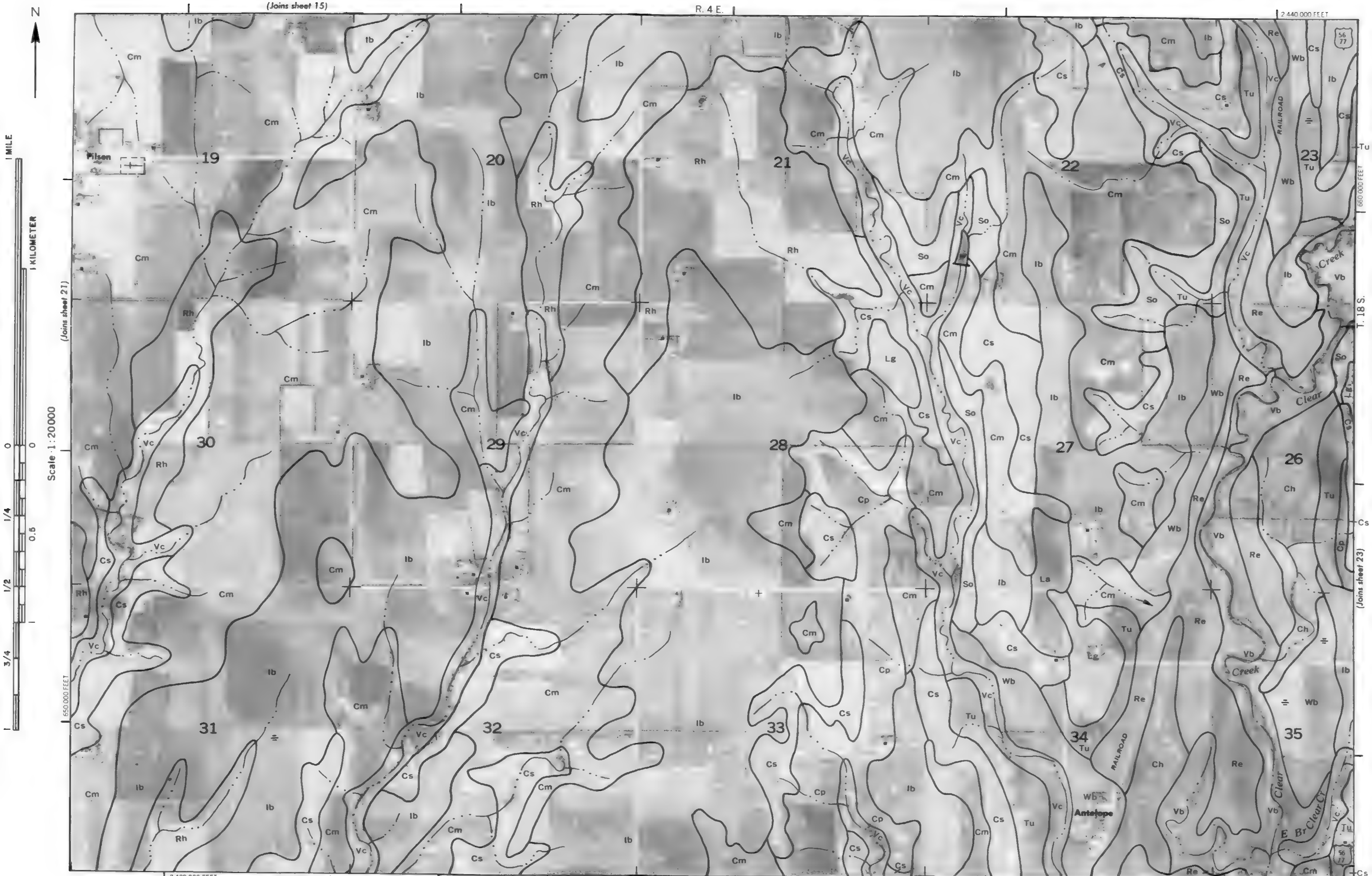

17
N
MORRIS COUNTY
R 5 E.
CHASE COUNTY
T 18 S
(Joins sheet 16)
(Joins sheet 24)
2 485 000 FEET
Middle Creek
water
1
2
3
10
11
12
13
14
15
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:20000

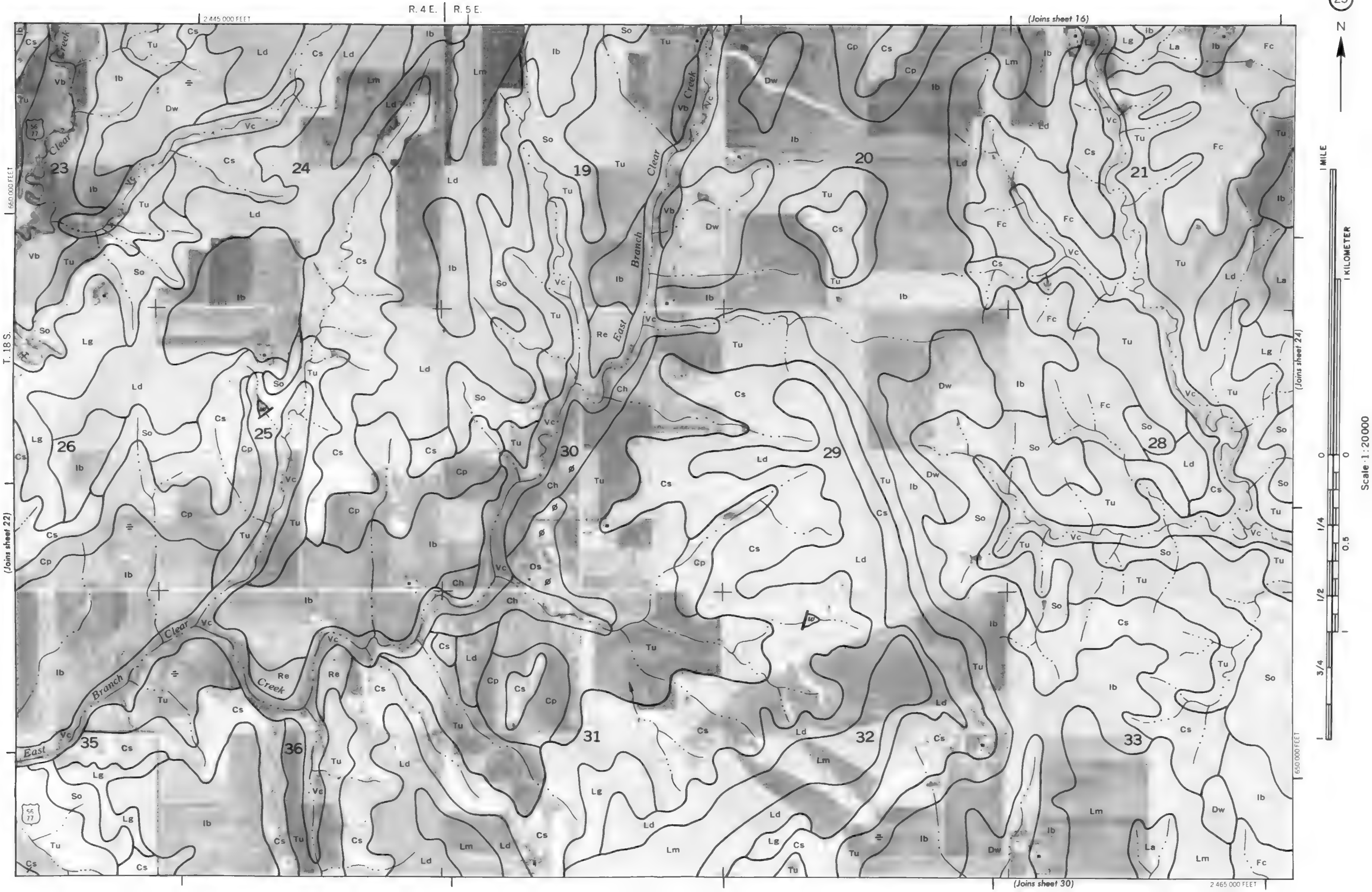

N
(Joins sheet 11)
R 1 E.
T. 18 S.
(Joins sheet 19)
(Joins sheet 25)
MC PHERSON COUNTY
Scale 1:20000
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0
0.5
1
Cottonwood
River
North
RAILROAD
RAILROAD
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35

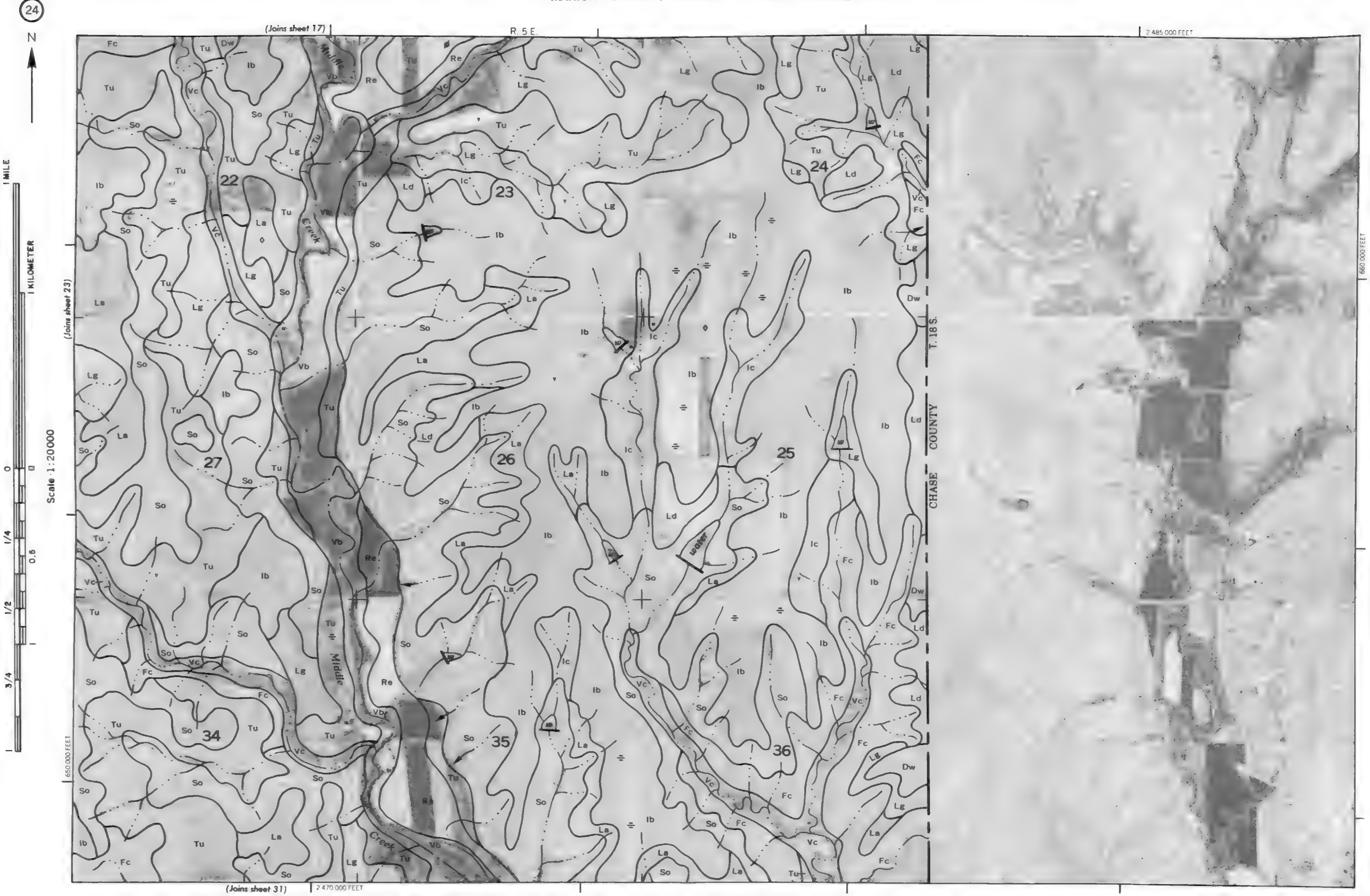

19
N
R. 1 E.
R. 2 E.
T. 18 S.
2 350 000 FEET
660 000 FEET
(Joins sheet 17)
(Joins sheet 18)
(Joins sheet 20)
(Joins sheet 26)
North
Cottonwood
River
RAILROAD
RAILROAD
15
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
1 MILE
1 KILOMETER
0
1/4
0.5
1/2
3/4
Scale 1:20000
Ib
Cp
Lv
Lt
Vc
Vb
Wb
Wc
Wd
Kp
Ch
Cm
Ic
Re
Ls
Dw


20
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
1
(Joins sheet 13)
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 27)
R. 2 E.
R. 3 E.
T. 18 S.
2 390 000 FEET
660 000 FEET
650 000 FEET
2 375 000 FEET
North
Cottonwood
River
MARION
RESERVOIR
19
20
22
23
24
25
26
27
29
30
31
32
34
35
Cm
Wb
Ib
Ch
Lm
Vb
Wc
Vc
Kp
Cp
Re
Ic


2 395 000 FEET
R. 3 E.
(Joins sheet 14)
(Joins sheet 22)
(Joins sheet 28)
(Joins sheet 20)
T. 18 S.
650 000 FEET
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0
0.5
1
Scale 1:20000
Mud Creek
Pilsen
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36


N
(Joins sheet 15)
R. 4 E.
2 440 000 FEET
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 29)
2 420 000 FEET
650 000 FEET
660 000 FEET
T. 18 S.
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5
Pilsen
Antelope
RAILROAD
Clear Creek
E Br Clear Cr
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35

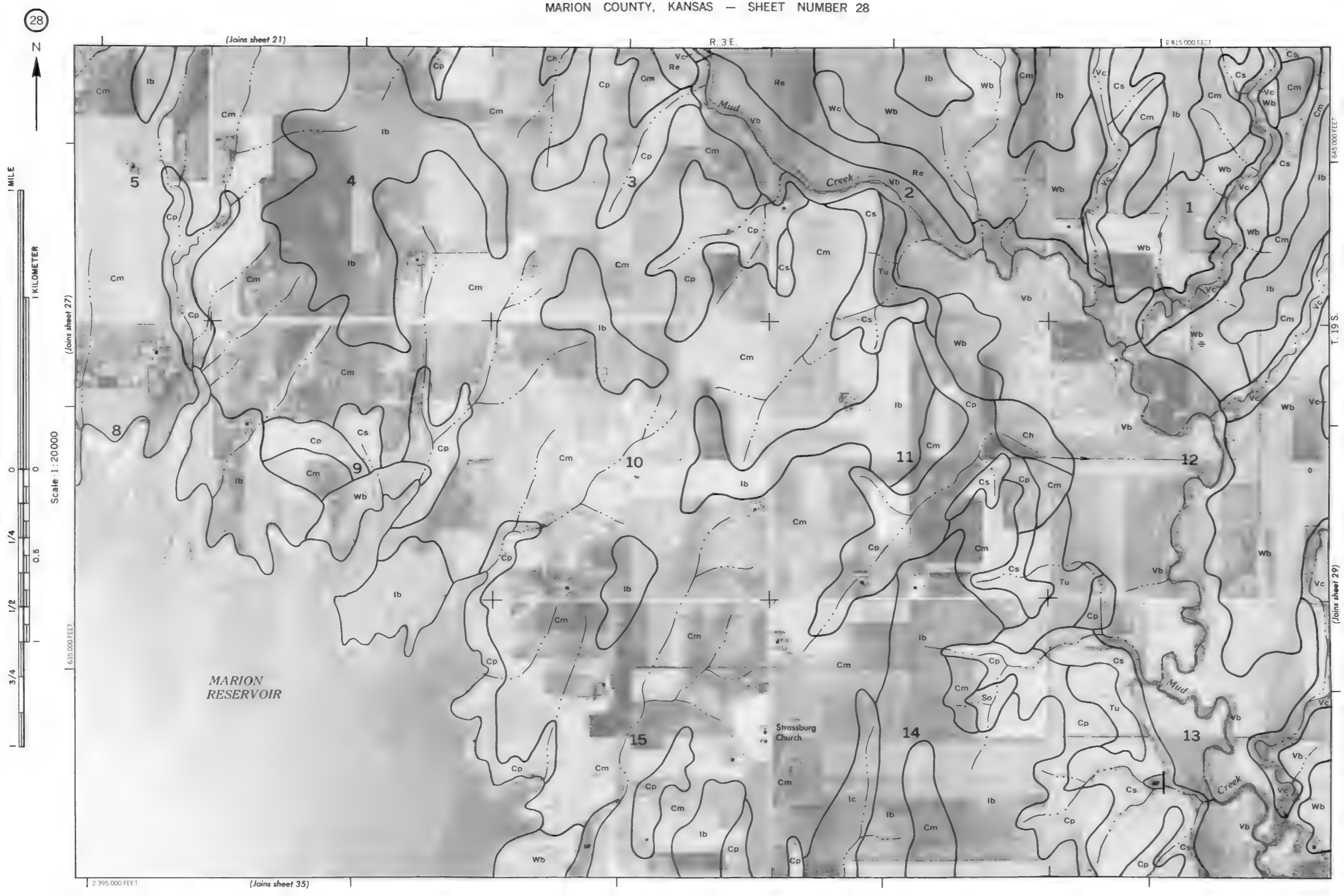

23
N
R. 4 E.
R. 5 E.
2 445 000 FEET
(Joins sheet 16)
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 30)
2 465 000 FEET
650 000 FEET
T. 18 S.
Clear Creek
East Branch Clear Creek
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
1 MILE
1 KILOMETER
0
1/4
0.5
1/2
3/4
1
Scale 1:20000

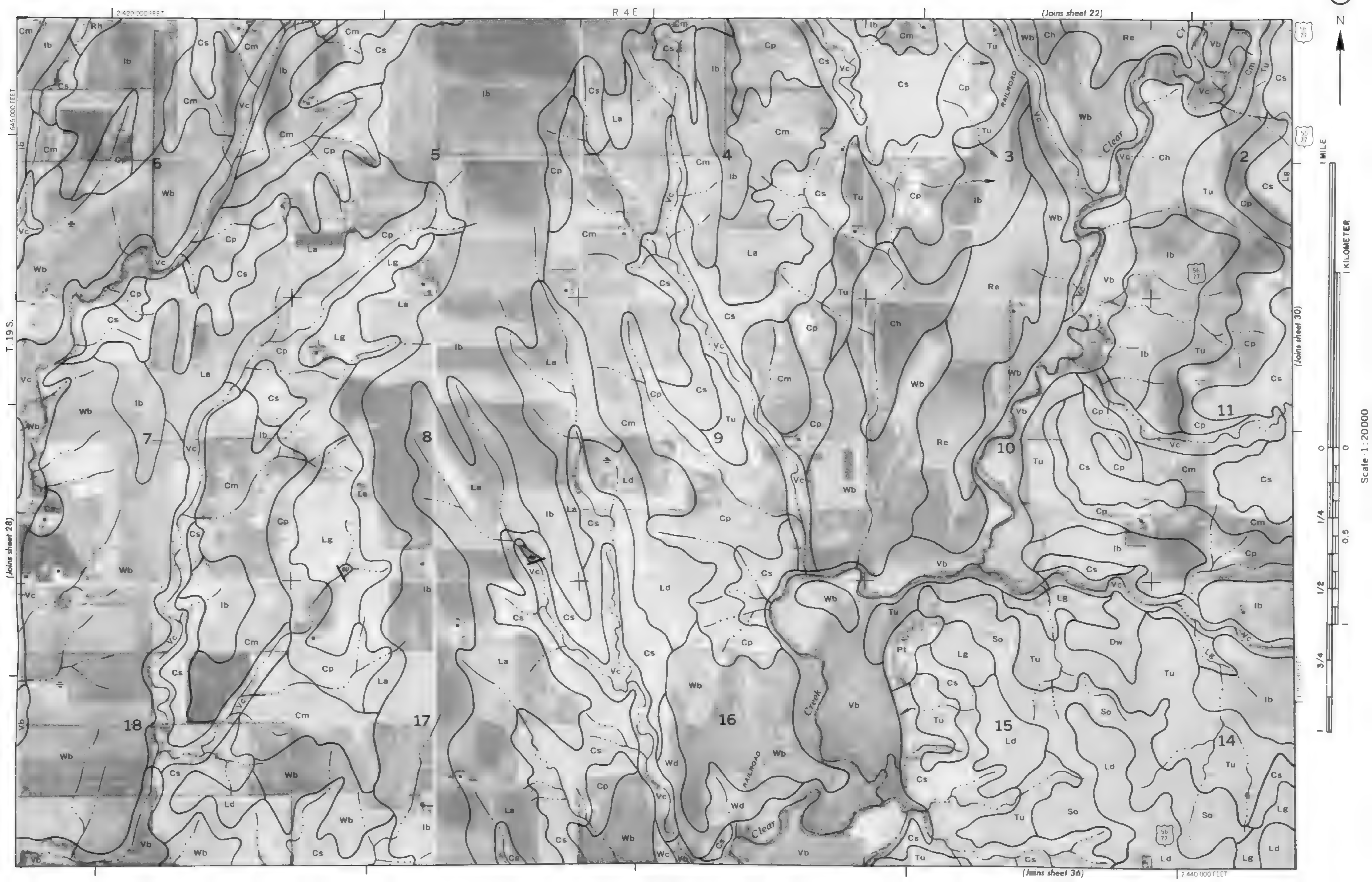

24
N
(Joins sheet 17)
R. 5 E.
2 485 000 FEET
(Joins sheet 23)
(Joins sheet 31)
2 470 000 FEET
650 000 FEET
T. 18 S.
CHASE COUNTY
Middle Creek
22
23
24
25
26
27
34
35
36
Water
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
0.5
1/2
3/4
1


25
N
(Joins sheet 18)
(Joins sheet 26)
(Joins sheet 32)
R. 1 E.
T. 19 S.
MC PHERSON COUNTY
2 325 000 FEET
645 000 FEET
635 000 FEET
2 345 000 FEET
RAILROAD
French Creek
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
1

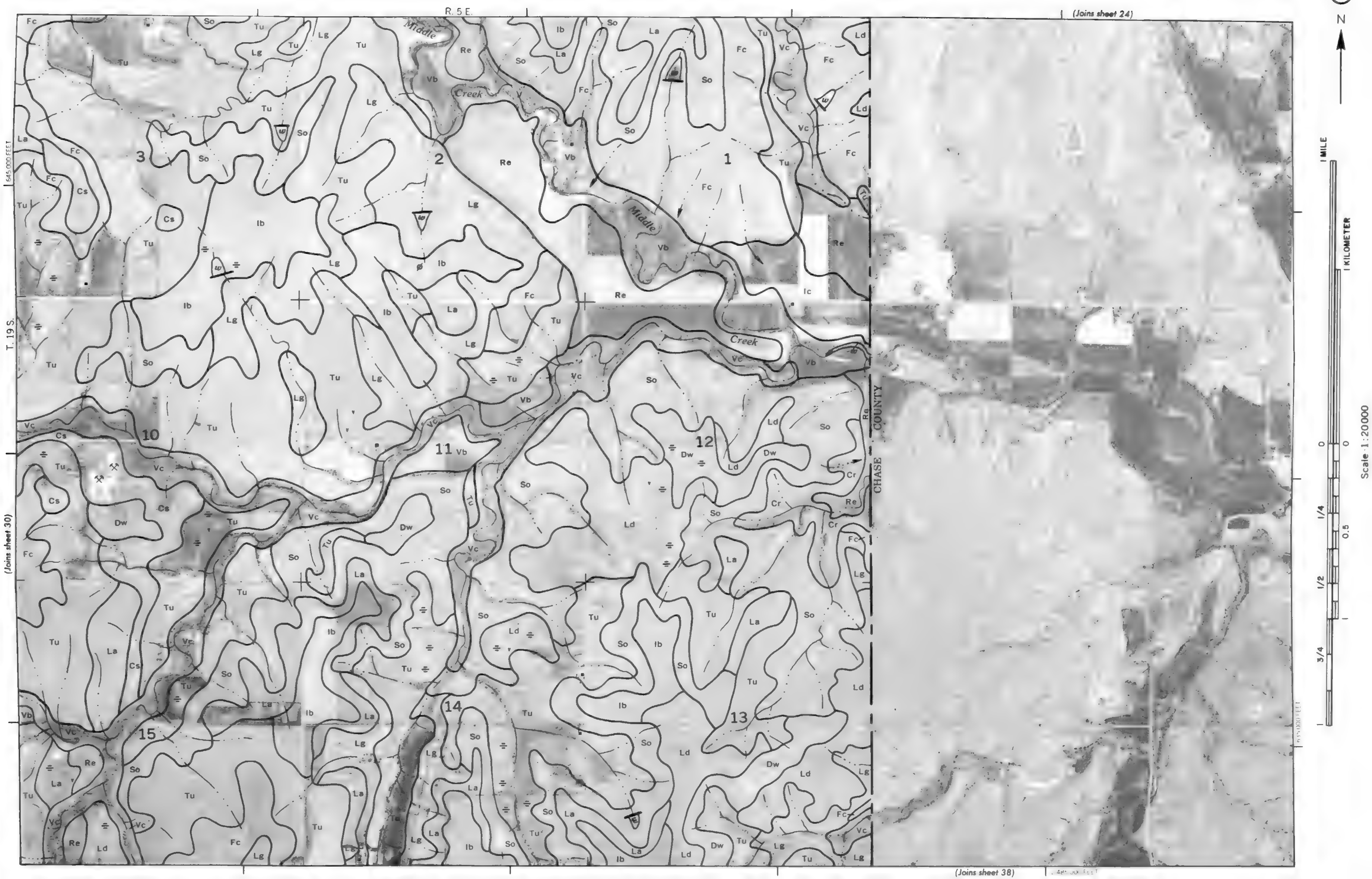

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 19)
R. 1 E.
R. 2 E.
2 370 000 FEET
645 000 FEET
(Joins sheet 25)
T. 19 S.
(Joins sheet 27)
635 000 FEET
2 350 000 FEET
(Joins sheet 33)
French Creek
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18


27
N
(Joins sheet 20)
R. 2 E. | R. 3 E.
2 375 000 FEET
645 000 FEET
T. 19 S.
(Joins sheet 26)
(Joins sheet 28)
(Joins sheet 34)
2 390 000 FEET
635 000 FEET
MARION RESERVOIR
1 MILE
1 KILOMETER
0
1/4
0.5
1/2
3/4
1
Scale 1:20000
Cm
Cp
Ib
Lm
Rh
Vb
Vc
Wb
1
2
3
5
8
10
11
12
13
14
15
18


28
N
(Joins sheet 21)
R. 3 E.
(Joins sheet 27)
(Joins sheet 29)
(Joins sheet 35)
T. 19 S.
MARION RESERVOIR
Mud Creek
Strassburg Church
1 MILE
1 KILOMETER
Scale 1:20000
2 395 000 FEET
635 000 FEET
645 000 FEET

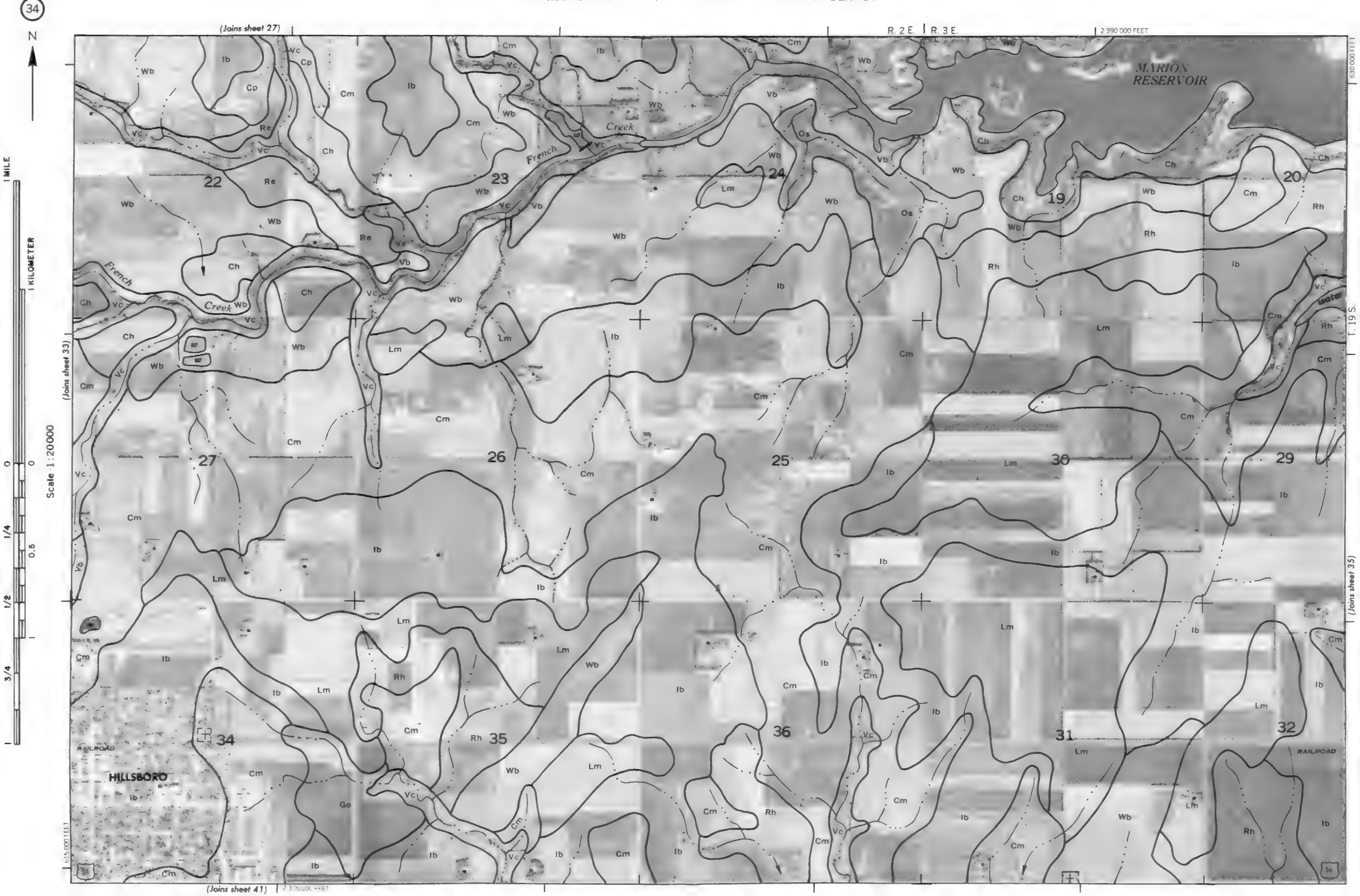

29
N
2 420 000 FEET
R 4 E
(Joins sheet 22)
645 000 FEET
T. 19 S.
(Joins sheet 28)
(Joins sheet 30)
(Joins sheet 36)
2 440 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
RAILROAD
Clear
Creek
Clear


30
N
(Joins sheet 23)
R. 4 E.
R. 5 E.
2 465 000 FEET
645 000 FEET
T. 19 S.
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 37)
2 445 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1


(Joins sheet 24)
(Joins sheet 30)
(Joins sheet 38)
R. 5 E.
T. 19 S.
Middle Creek
CHASE COUNTY
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:20000
645 000 FEET


32
N
(Joins sheet 25)
R. 1 E.
2 345 000 FEET
630 000 FEET
T. 19 S.
(Joins sheet 33)
(Joins sheet 39)
2 325 000 FEET
615 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
MC PHERSON COUNTY
RAILROAD
Lehigh
Cottonwood
River
South
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
56
15
Ls
Ed
Ib
Ic
Lm
Lt
Wb
Wc
Vc
Vb
Cp
Cm
Go
Rh
Re
Wd


33
R. 1 E.
R. 2 E.
(Joins sheet 26)
(Joins sheet 34)
(Joins sheet 40)
(Joins sheet 31)
T. 19 S.
2 350 000 FEET
630 000 FEET
2 370 000 FEET
615 000 FEET
French Creek
RAILROAD
HILLSBORO
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

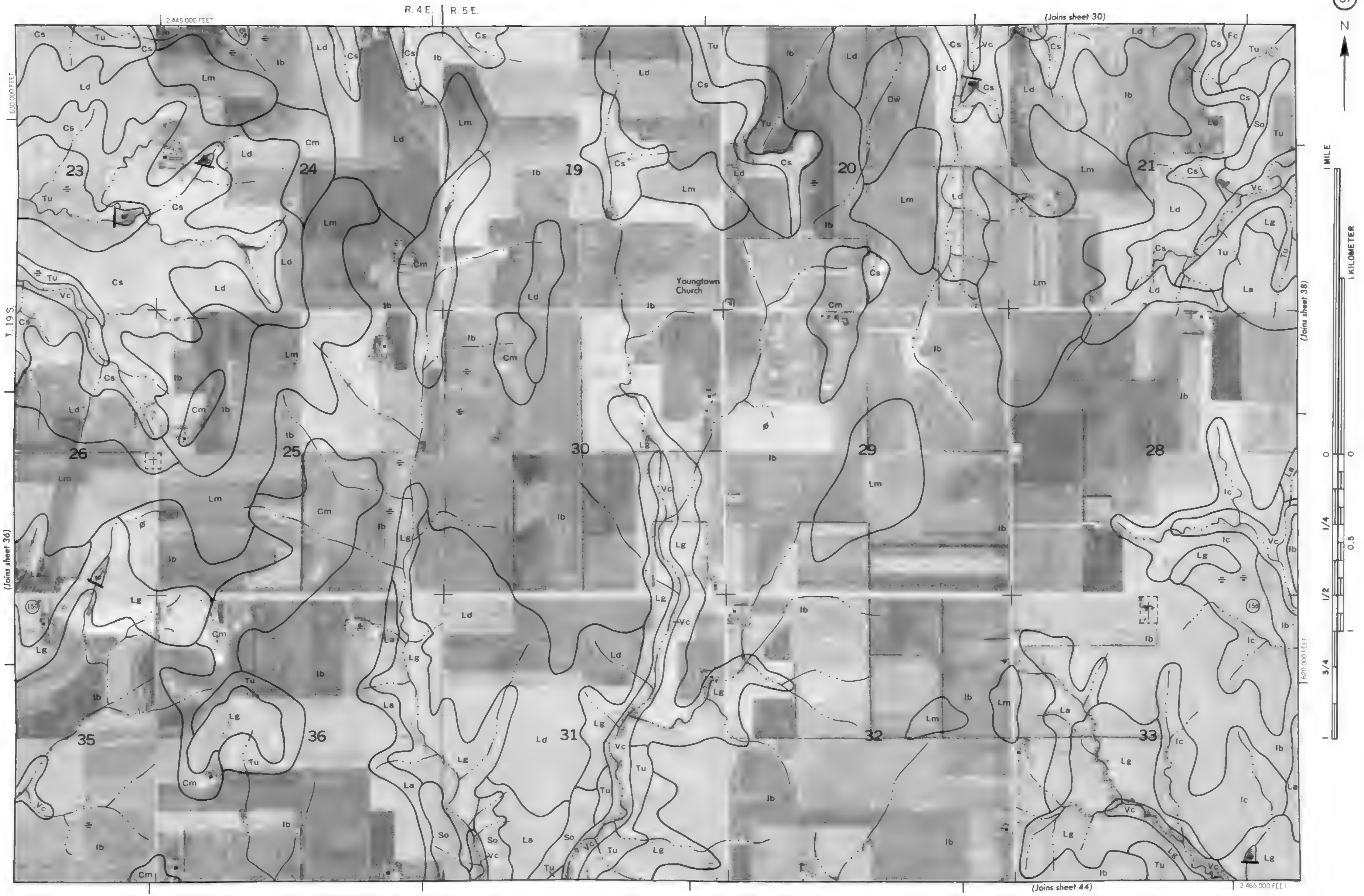

34
N
(Joins sheet 27)
R. 2 E. | R. 3 E.
2 390 000 FEET
630 000 FEET
MARION RESERVOIR
French Creek
(Joins sheet 33)
(Joins sheet 35)
T. 19 S.
(Joins sheet 41)
HILLSBORO
RAILROAD
1 MILE
1 KILOMETER
Scale 1:20 000
0
1/4
1/2
3/4
1
0
0.5
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
Wb
Ib
Cp
Ch
Re
Vc
Cm
Vb
Os
Lm
Rh
Go
615 000 FEET
56

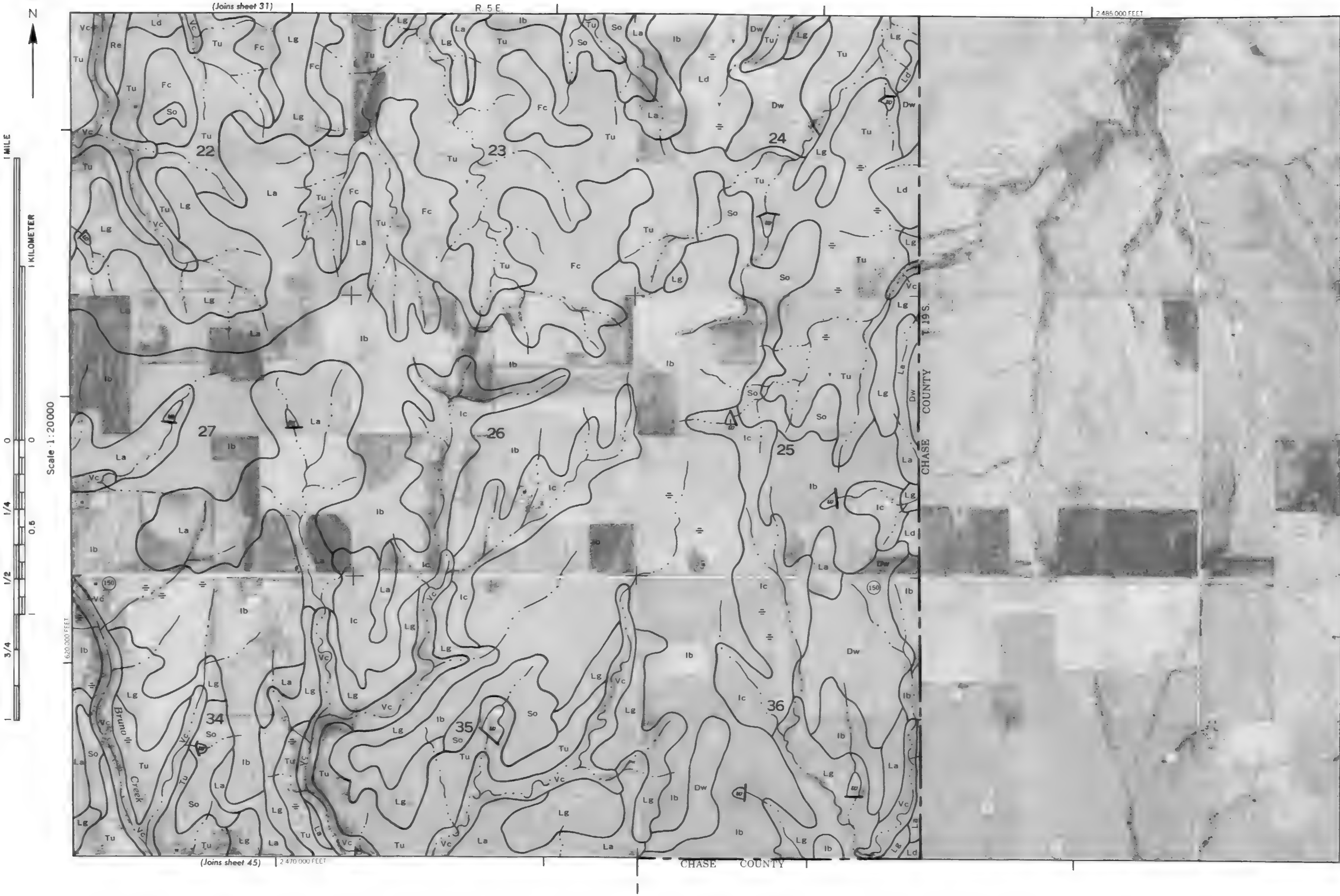

35
N
(Joins sheet 28)
R. 3 E.
2 395 000 FEET
630 000 FEET
T. 19 S.
(Joins sheet 34)
(Joins sheet 36)
(Joins sheet 42)
620 000 FEET
415 000 FEET
MARION RESERVOIR
MARION DAM
North
Cottonwood
River
South
Mud
Creek
RAILROAD
Canada
56
20
22
23
24
25
26
28
29
32
33
34
35
36
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:20000

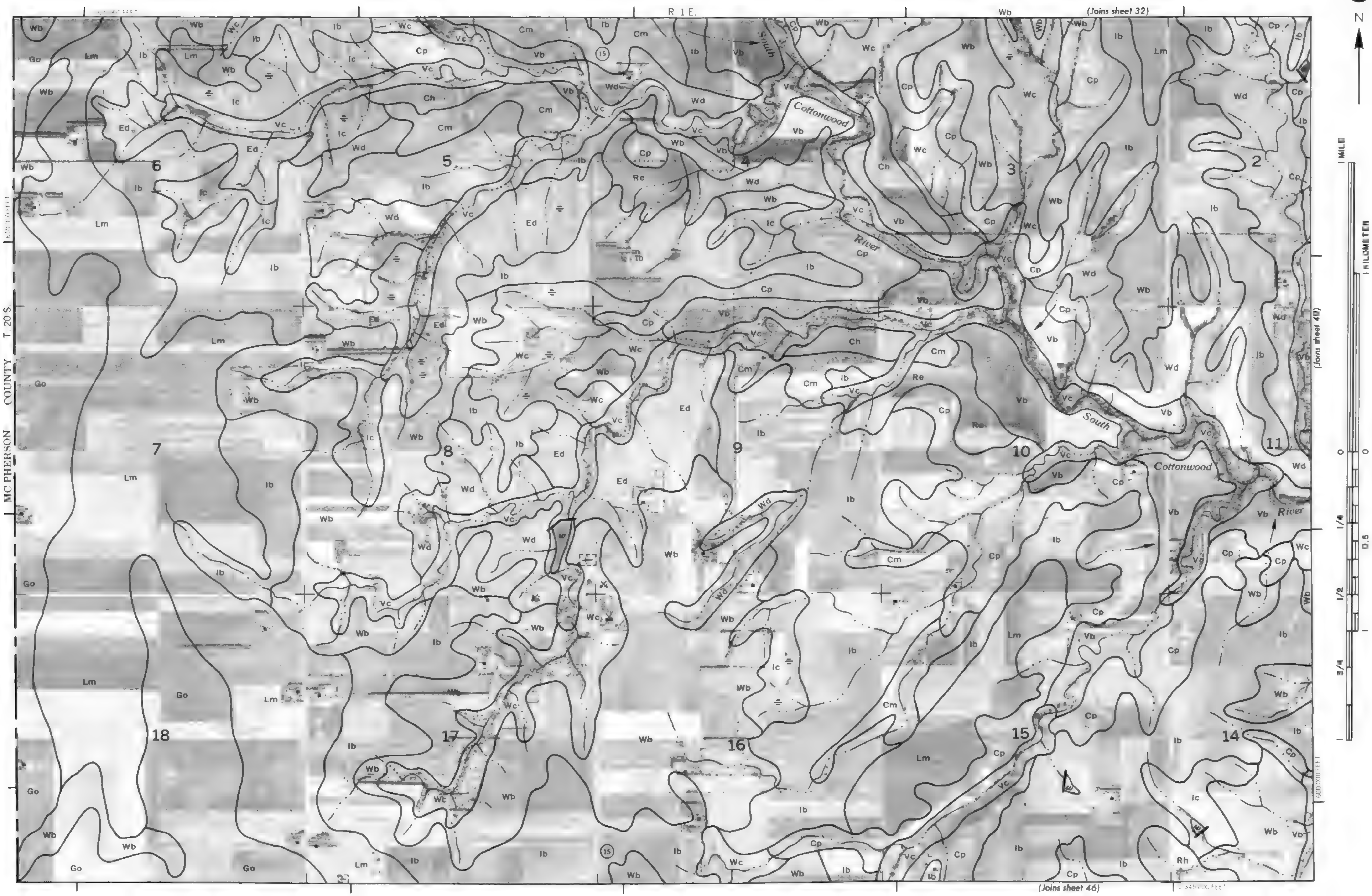
36

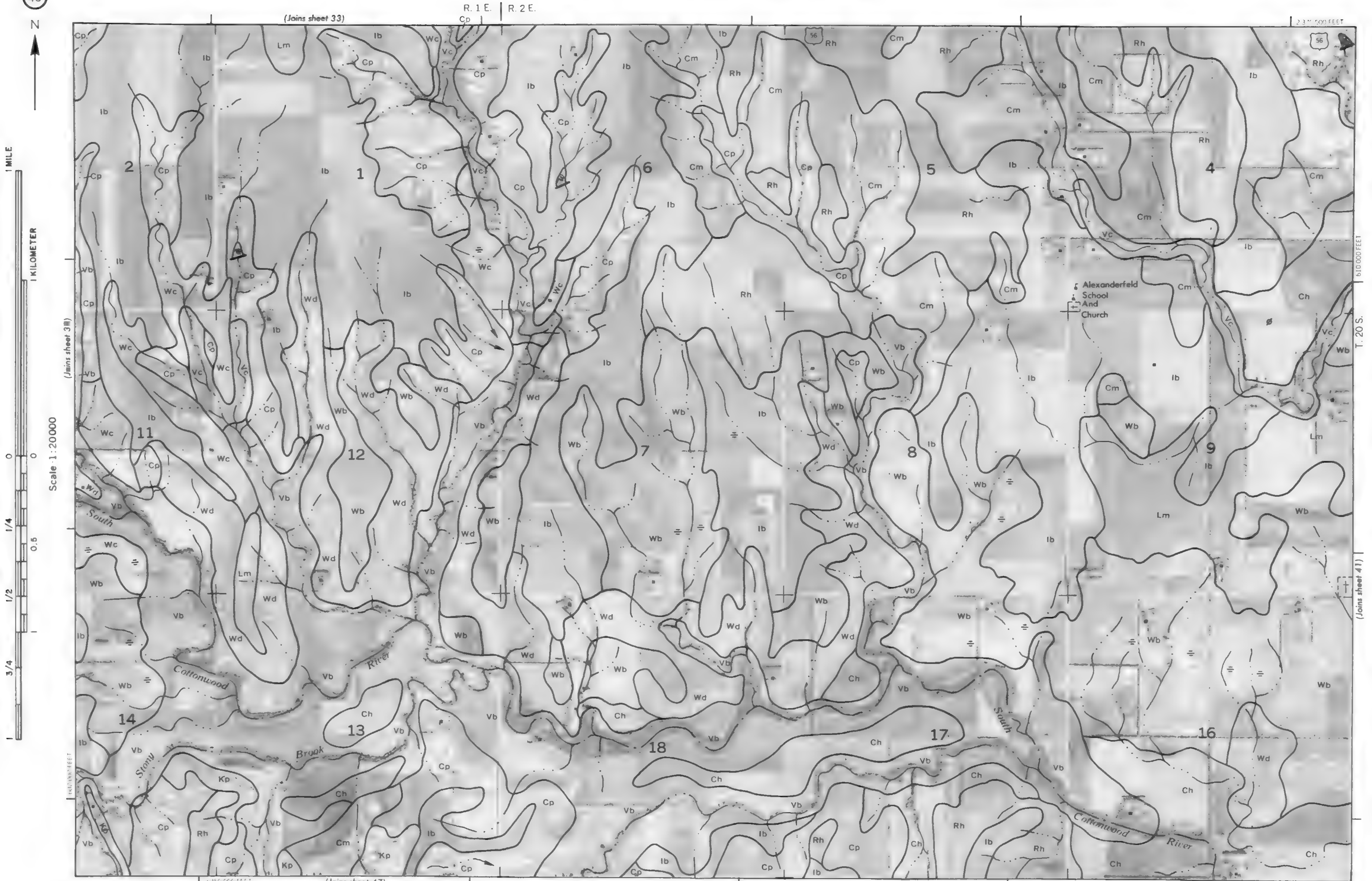

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
(Joins sheet 29)
R. 4 E
2 440 000 FEET
630 000 FEET
(Joins sheet 35)
(Joins sheet 37)
(Joins sheet 43)
T. 19 S.
620 000 FEET
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
Mud Creek
Clear Creek
Cottonwood River
RAILROAD
MARION
(county seat)
56
77
150

MARION COUNTY, KANSAS — SHEET NUMBER 37



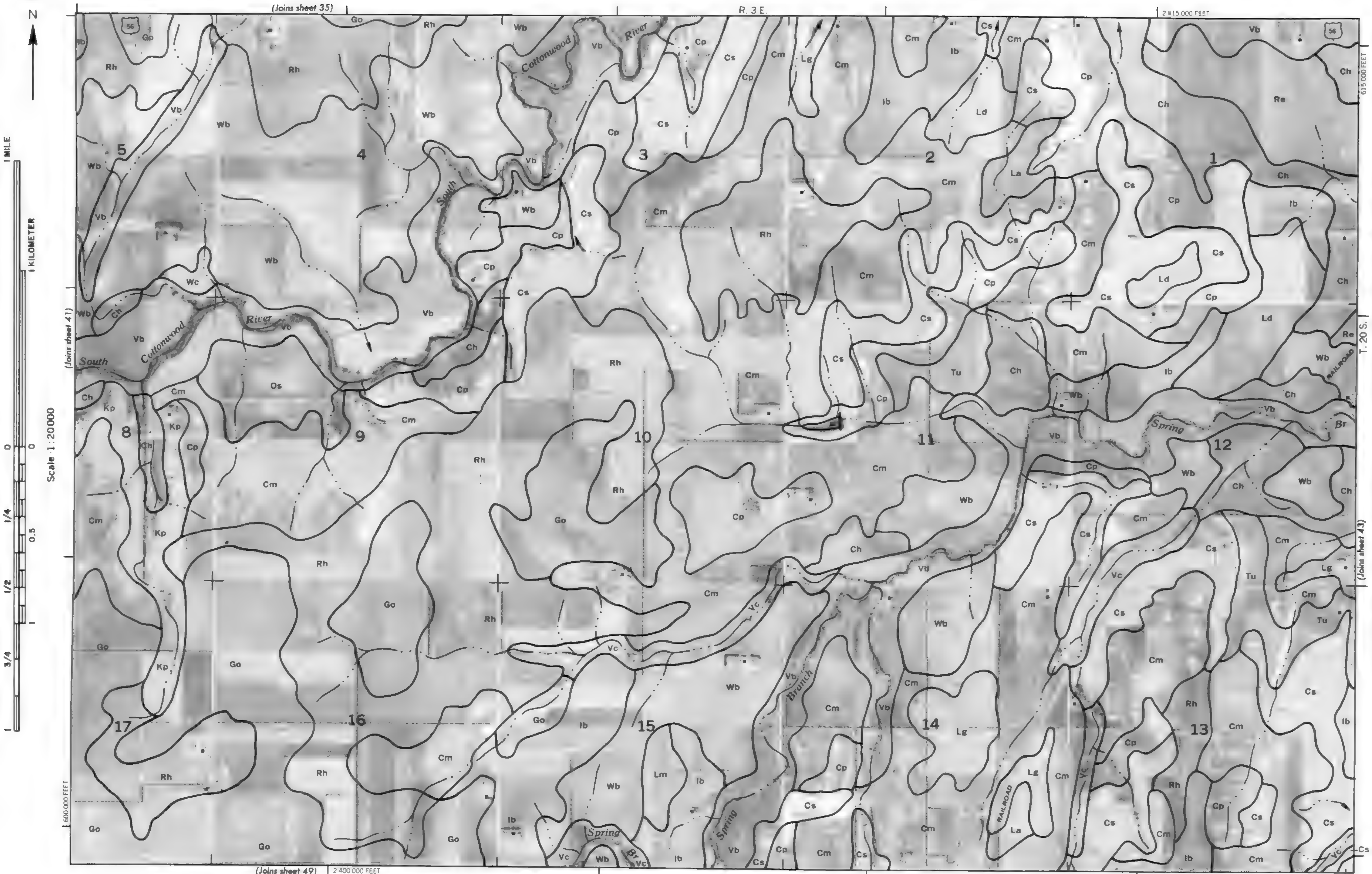

(Joins sheet 31)
R. 5 E.
2 485 000 FEET
630 000 FEET
620 000 FEET
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:20000
T. 19 S.
CHASE COUNTY
Bruno Creek
22
23
24
25
26
27
34
35
36
150
(Joins sheet 45)
2 470 000 FEET
CHASE COUNTY

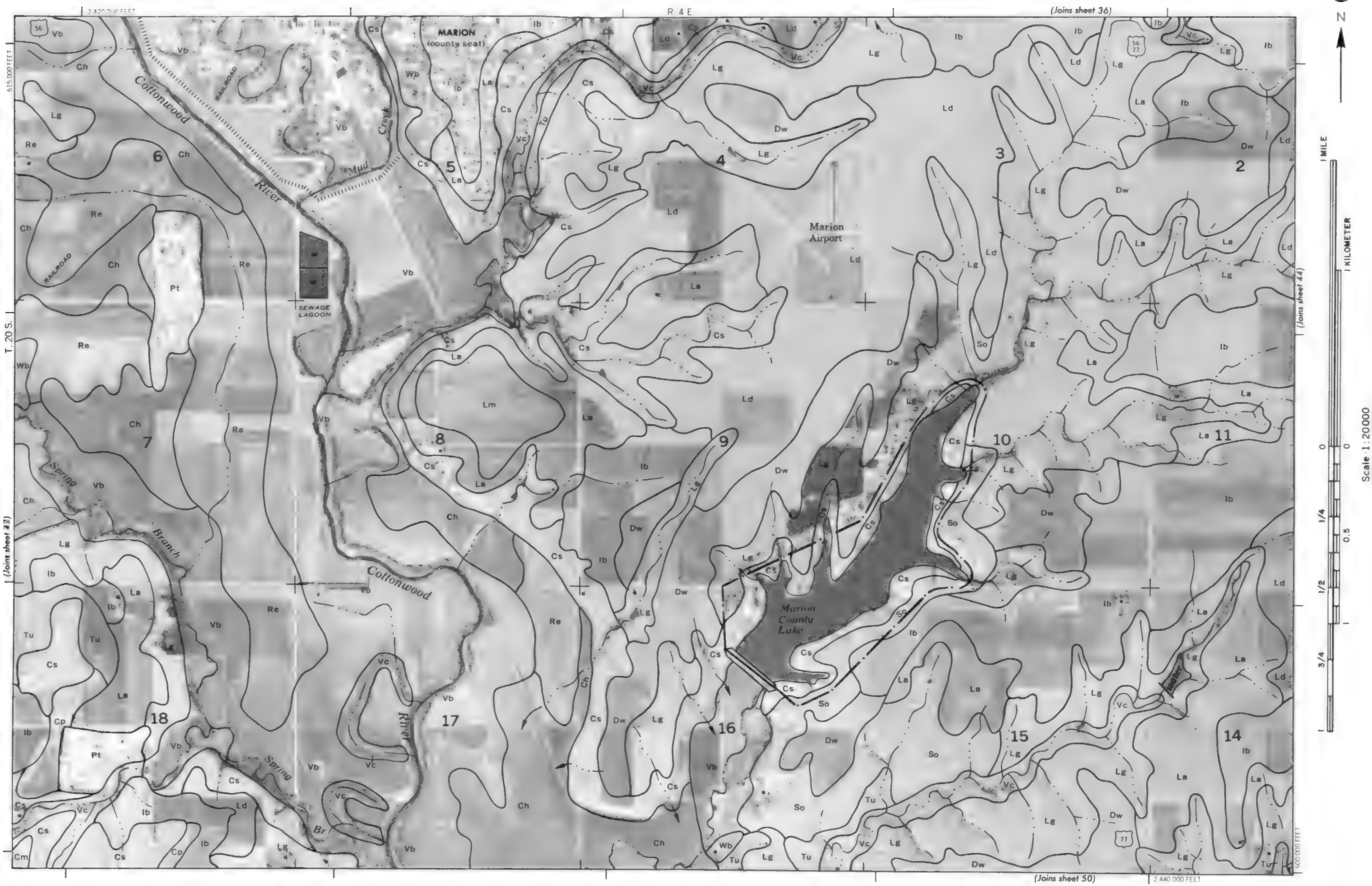

R 1 E.
(Joins sheet 32)
(Joins sheet 41)
(Joins sheet 46)
T. 20 S.
MC PHERSON COUNTY
South
Cottonwood
River
N
1 MILE
1 KILOMETER
Scale 1:20000
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18
15

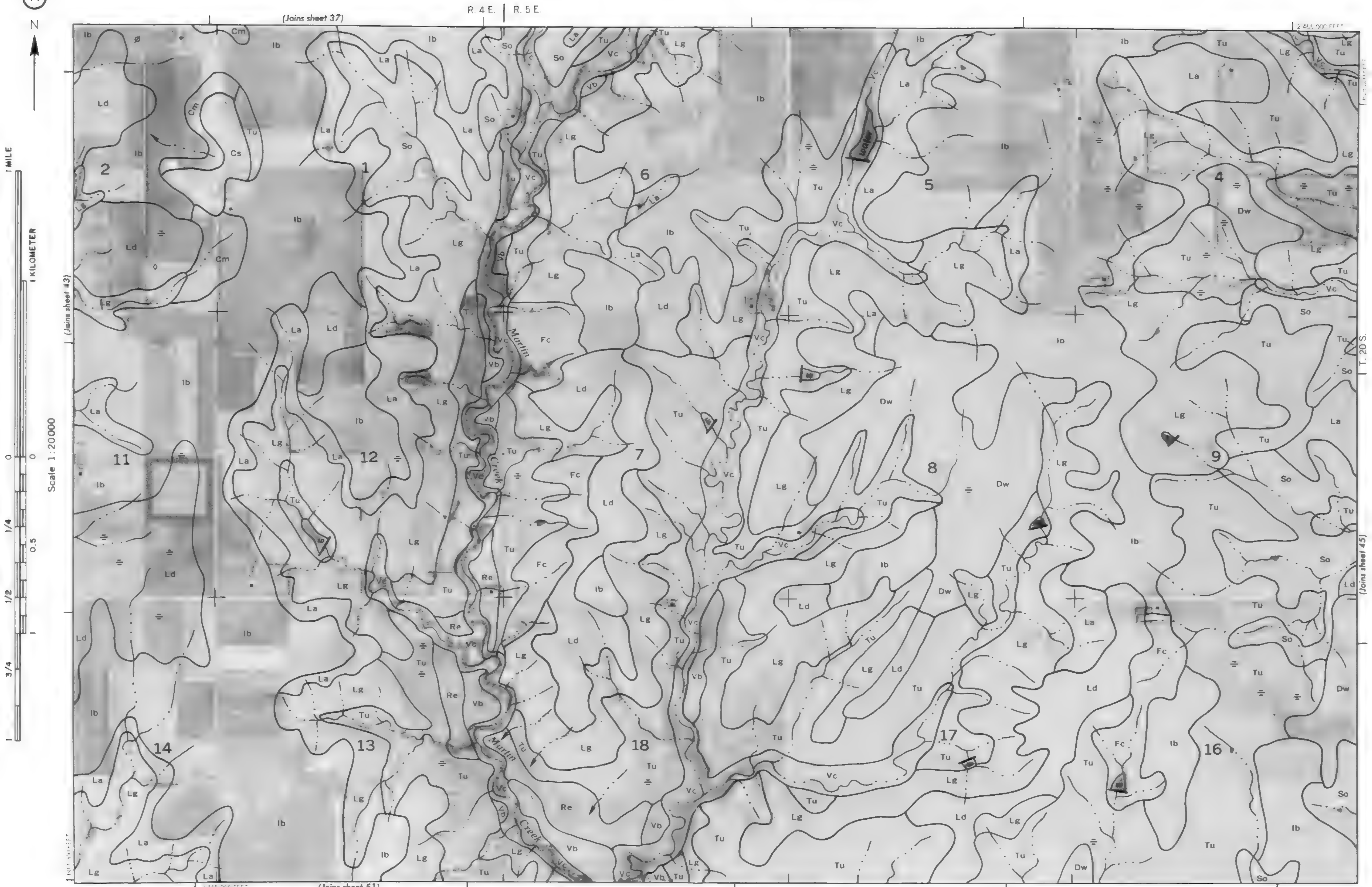

N
1 MILE
1 KILOMETER
Scale 1:20 000
(Joins sheet 33)
R. 1 E.
R. 2 E.
T. 20 S.
(Joins sheet 41)
(Joins sheet 47)
Alexanderfeld School And Church
South Cottonwood River
Stony Brook
South
Cottonwood River
56

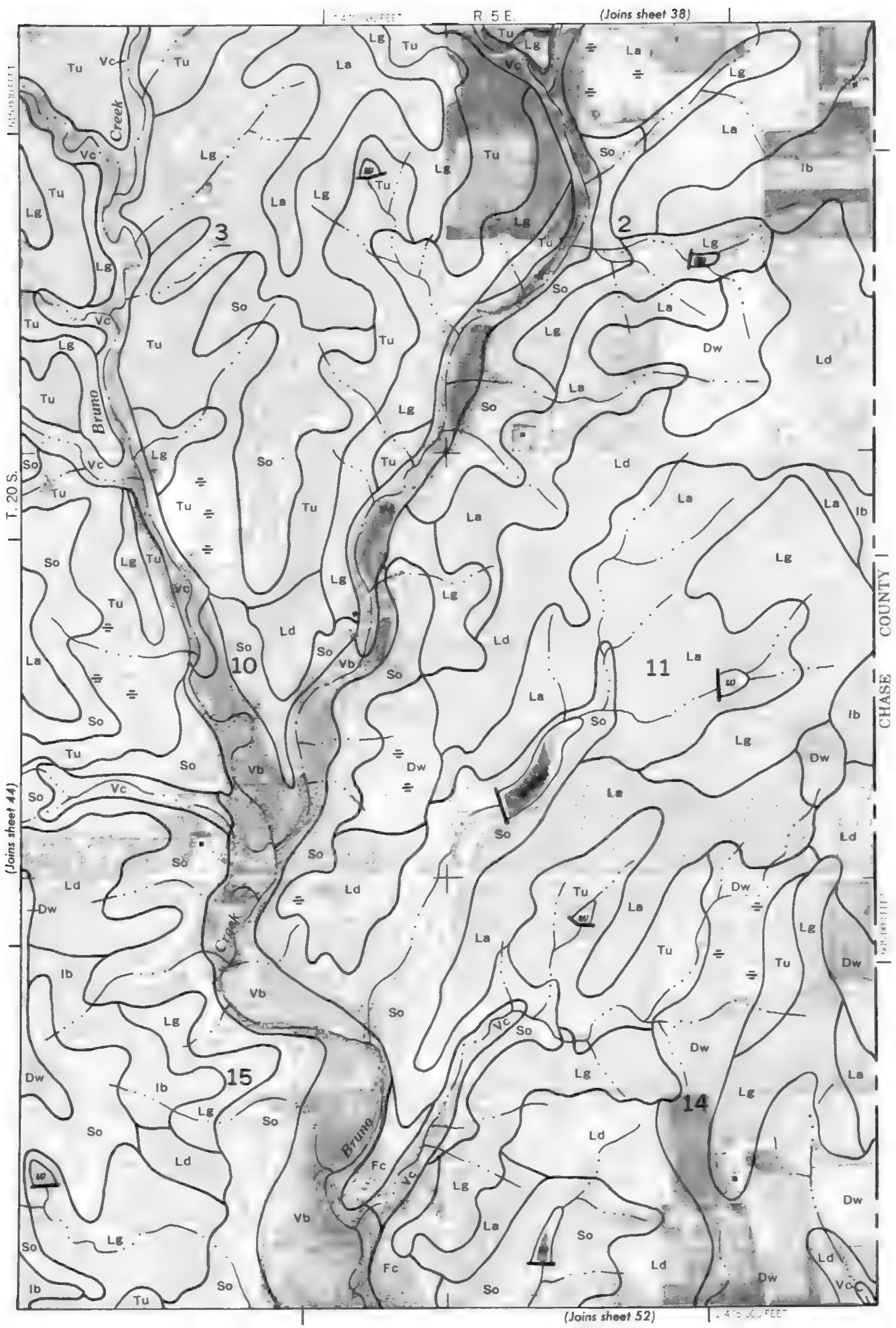

41
N
2 375 000 FEET
R. 2 E.
R. 3 E.
(Joins sheet 34)
(Joins sheet 42)
(Joins sheet 40)
(Joins sheet 48)
2 395 000 FEET
600 000 FEET
T. 20 S.
HILLSBORO
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
South Cottonwood River
Creek
Antelope
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18
Ib
Cm
Ch
Rh
Wb
Vc
Vb
Lm
Ic
Kp
Cp
Os
Go

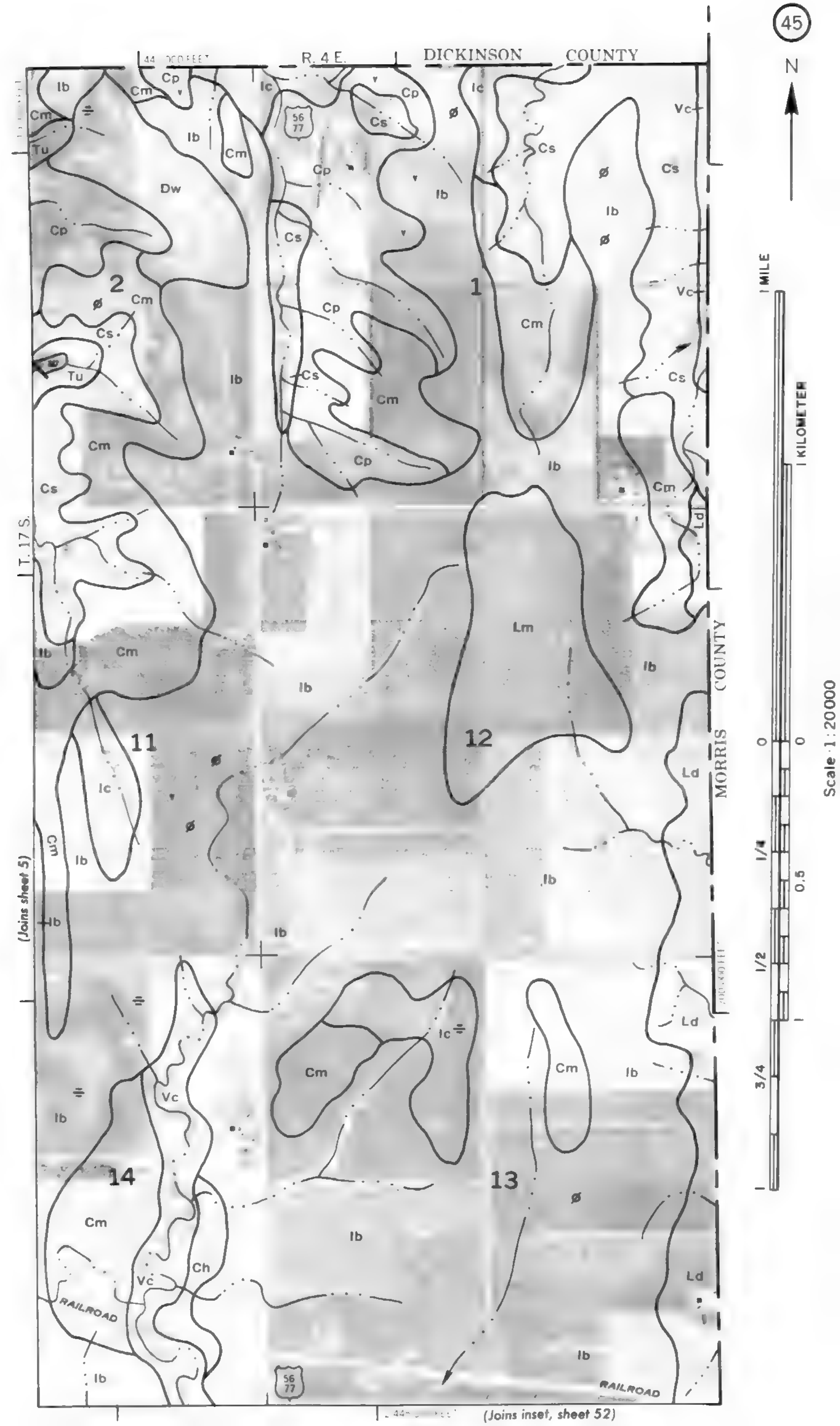
MARION COUNTY, KANSAS — SHEET NUMBER 42

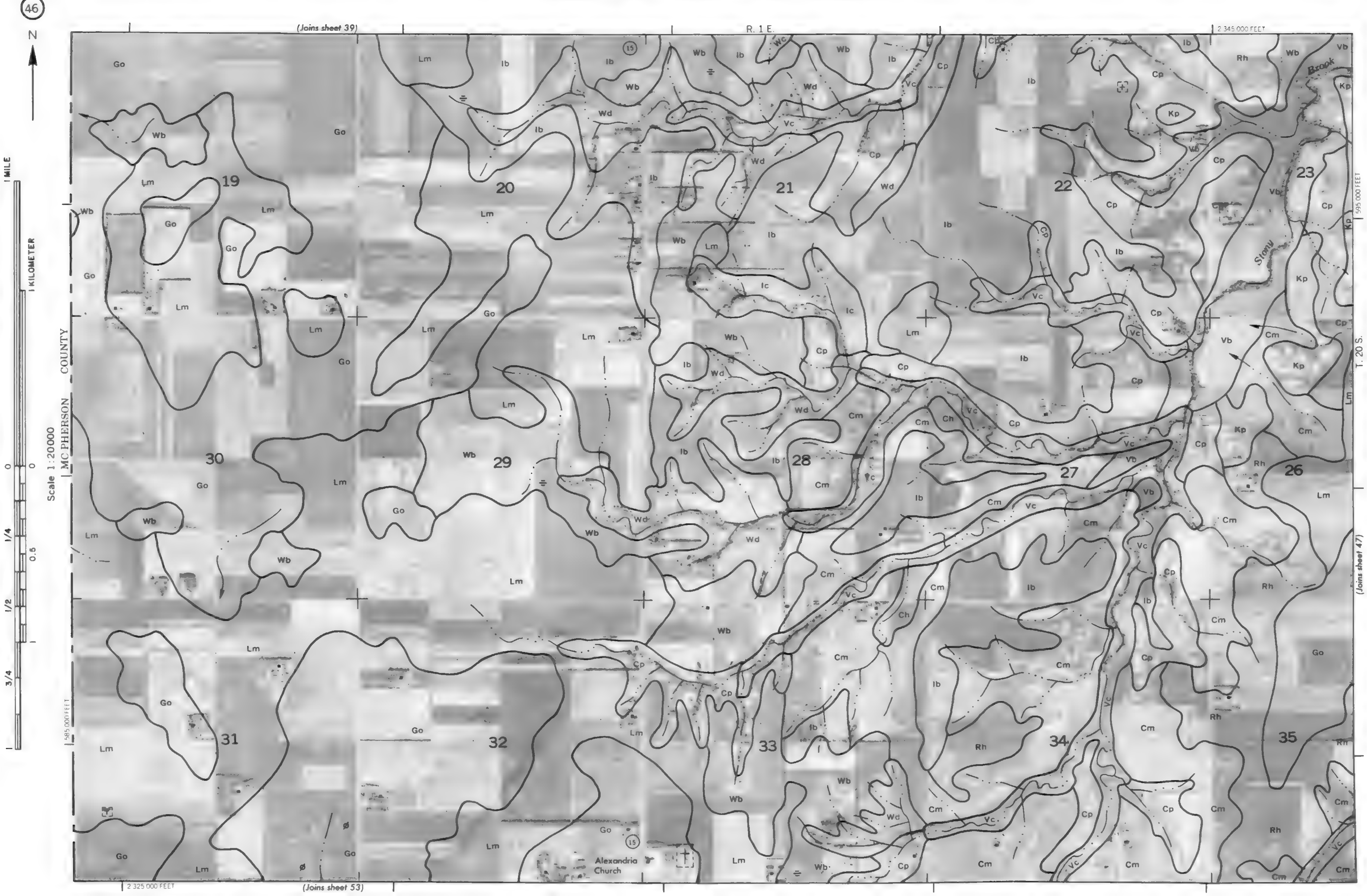


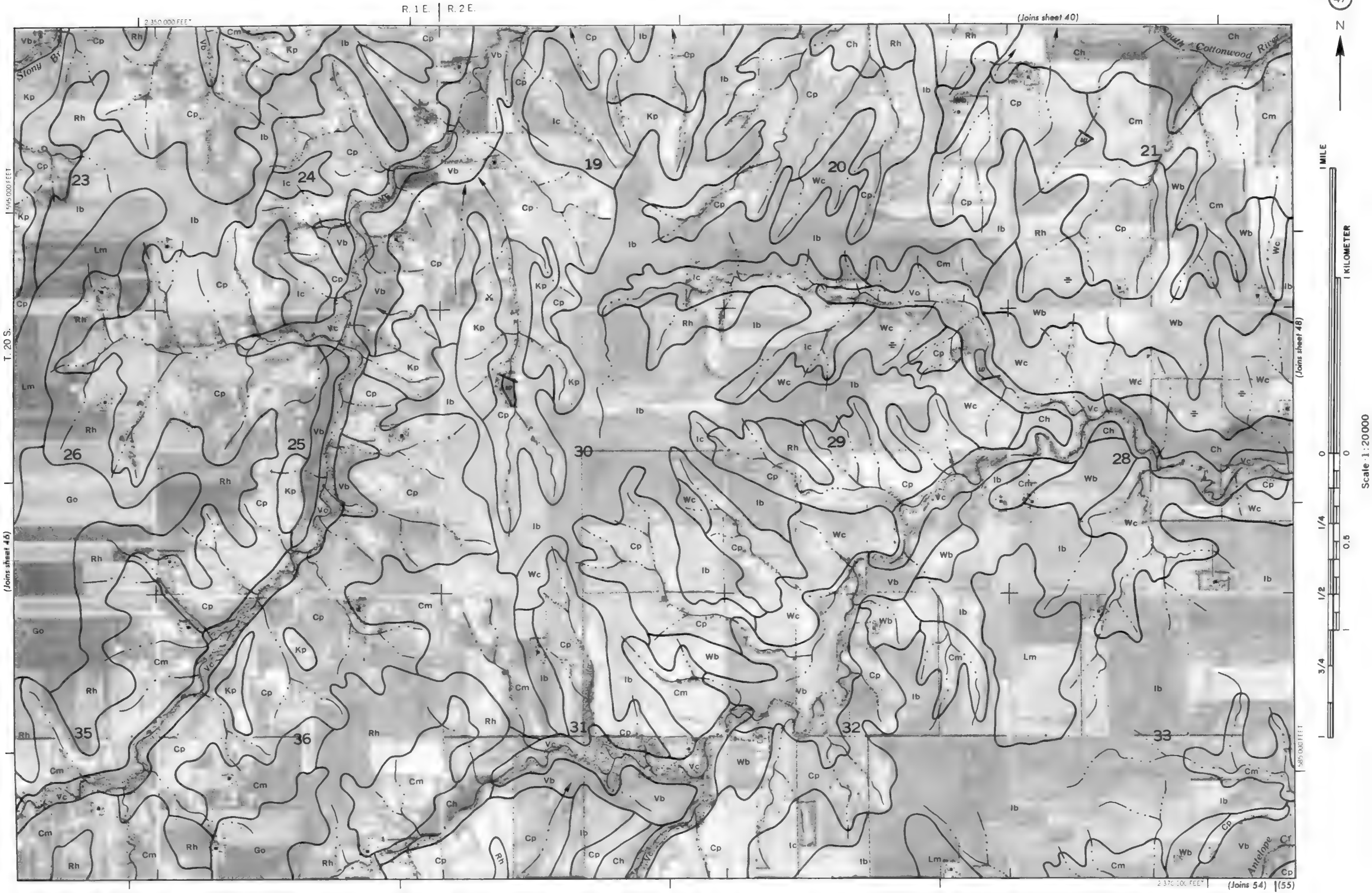

43
N
R 4 E
(Joins sheet 36)
(Joins sheet 44)
(Joins sheet 50)
(Joins sheet 42)
T. 20 S.
MARION
(county seat)
Marion Airport
Marion County Lake
SEWAGE LAGOON
Cottonwood River
Mud Creek
Spring Branch
RAILROAD
1 MILE
1 KILOMETER
Scale 1:20000
2 440 000 FEET
615 000 FEET
600 000 FEET


N
R. 4 E.
R. 5 E.
(Joins sheet 37)
(Joins sheet 43)
(Joins sheet 45)
(Joins sheet 51)
T. 20 S.
Martin Creek
Martin Creek
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1

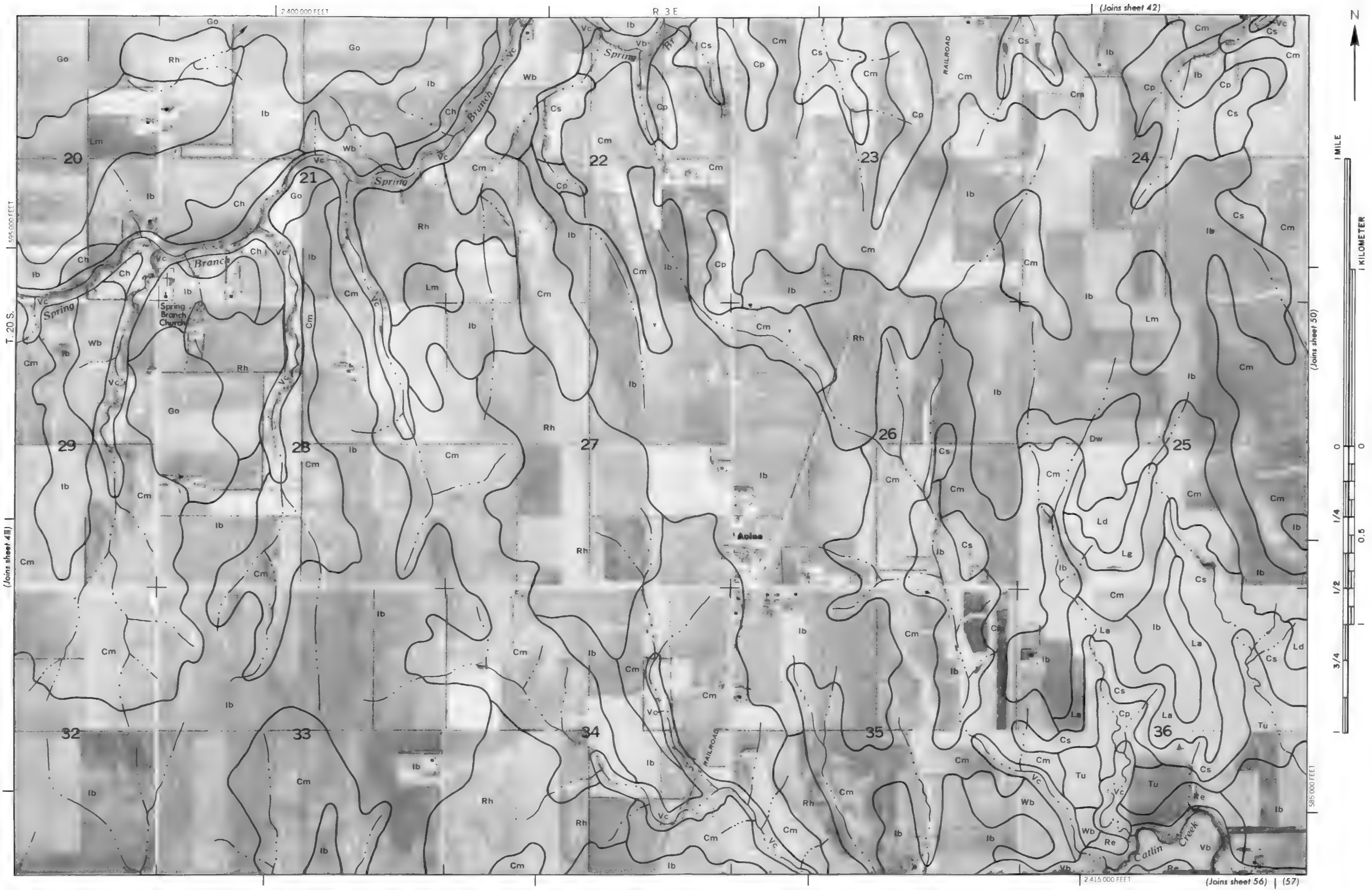

R. 5 E.
(Joins sheet 38)
Bruno Creek
Bruno Creek
T. 20 S.
(Joins sheet 44)
CHASE COUNTY
(Joins sheet 52)

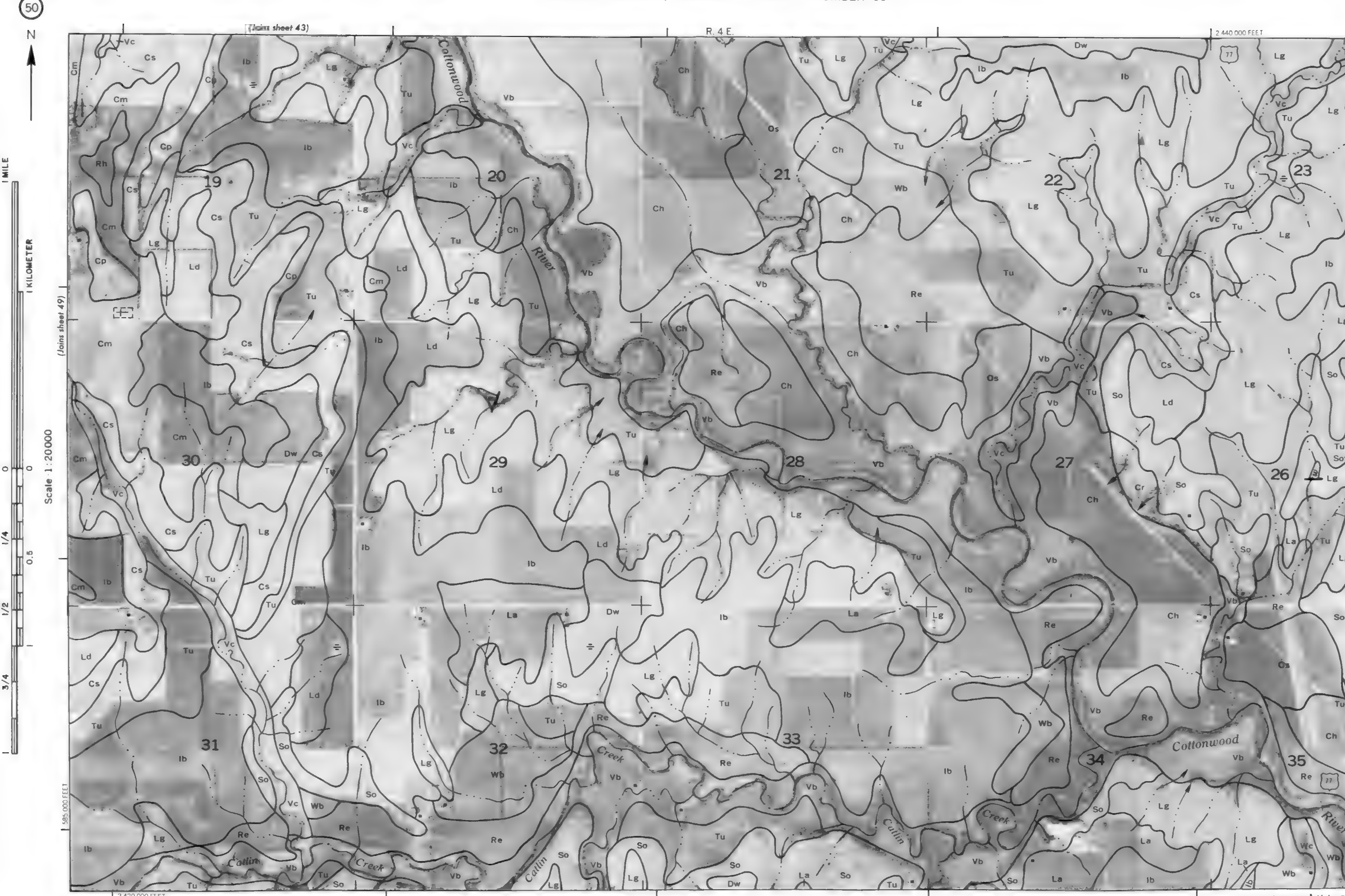

45
R. 4 E.
DICKINSON COUNTY
T. 17 S.
(Joins sheet 5)
MORRIS COUNTY
RAILROAD
RAILROAD
(Joins inset, sheet 52)
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0
0.5
Scale 1:20000


N
(Joins sheet 39)
R. 1 E.
2 345 000 FEET
595 000 FEET
T. 20 S.
(Joins sheet 47)
(Joins sheet 53)
2 325 000 FEET
585 000 FEET
MC PHERSON COUNTY
Scale 1:20000
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Stony Brook
Alexandria Church
15
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
Go
Lm
Wb
Ib
Wd
Vc
Cp
Kp
Rh
Cm
Ch
Ic
Vb
Cb

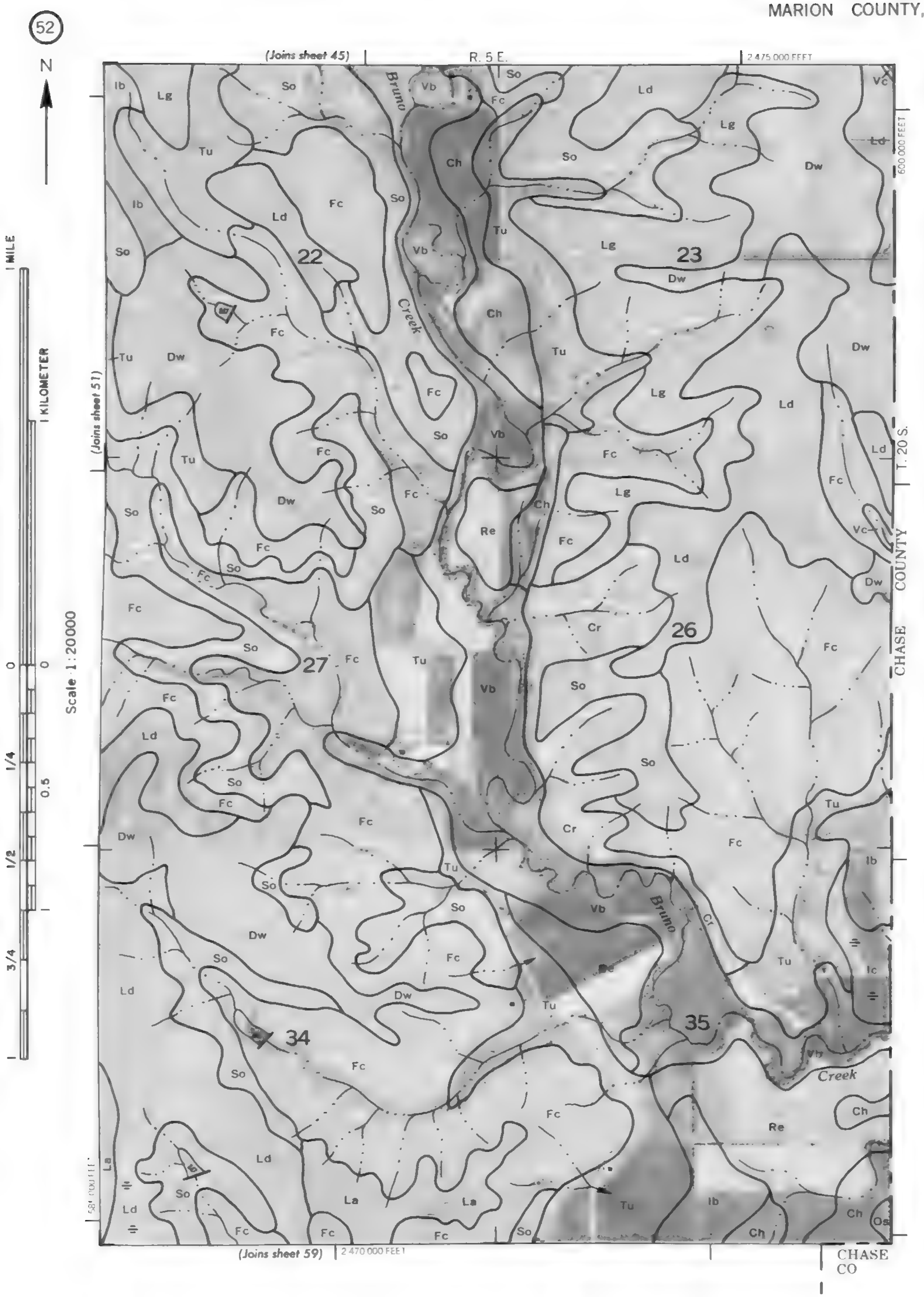

R. 1 E.
R. 2 E.
2 350 000 FEET
(Joins sheet 40)
(Joins sheet 48)
(Joins sheet 46)
T. 20 S.
595 000 FEET
585 000 FEET
2 370 000 FEET
(Joins 54)
(55)
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
South Cottonwood River
Stony Br
Antelope Cr
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
Cp
Ib
Rh
Kp
Vb
Cm
Ch
Ic
Lm
Go
Vc
Wb
Wc

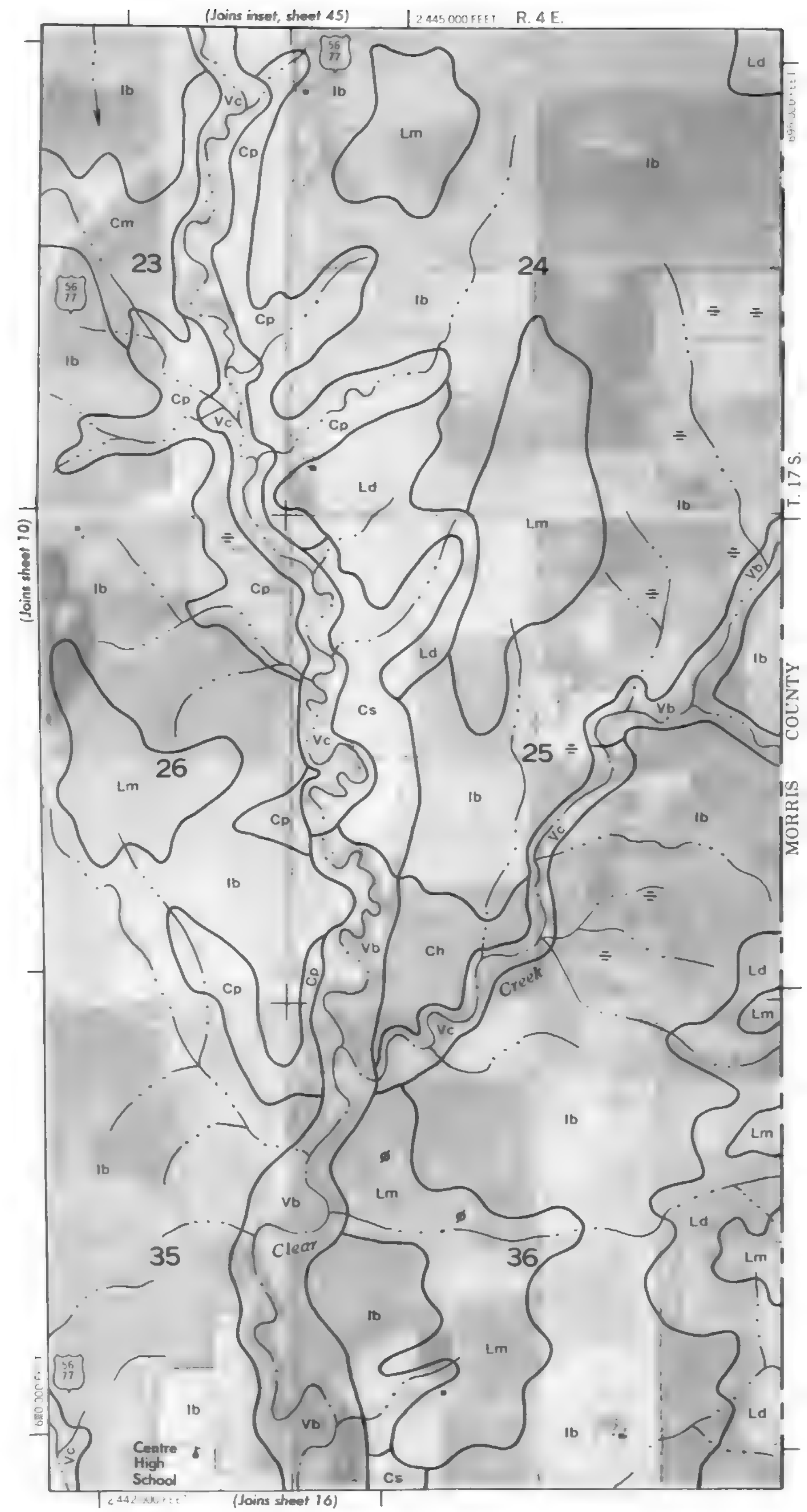

N
1 MILE
1 KILOMETER
0
1/4
0.5
1/2
3/4
1
Scale 1:20000
(Joins sheet 41)
(Joins sheet 47)
(Joins sheet 49)
(Joins sheet 55)
(56)
R. 2 E.
R. 3 E.
T. 20 S.
2 395 000 FEET
595 000 FEET
585 000 FEET
2 375 000 FEET
Antelope
Creek
Spring
Branch
Ebenfeld
Church
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36

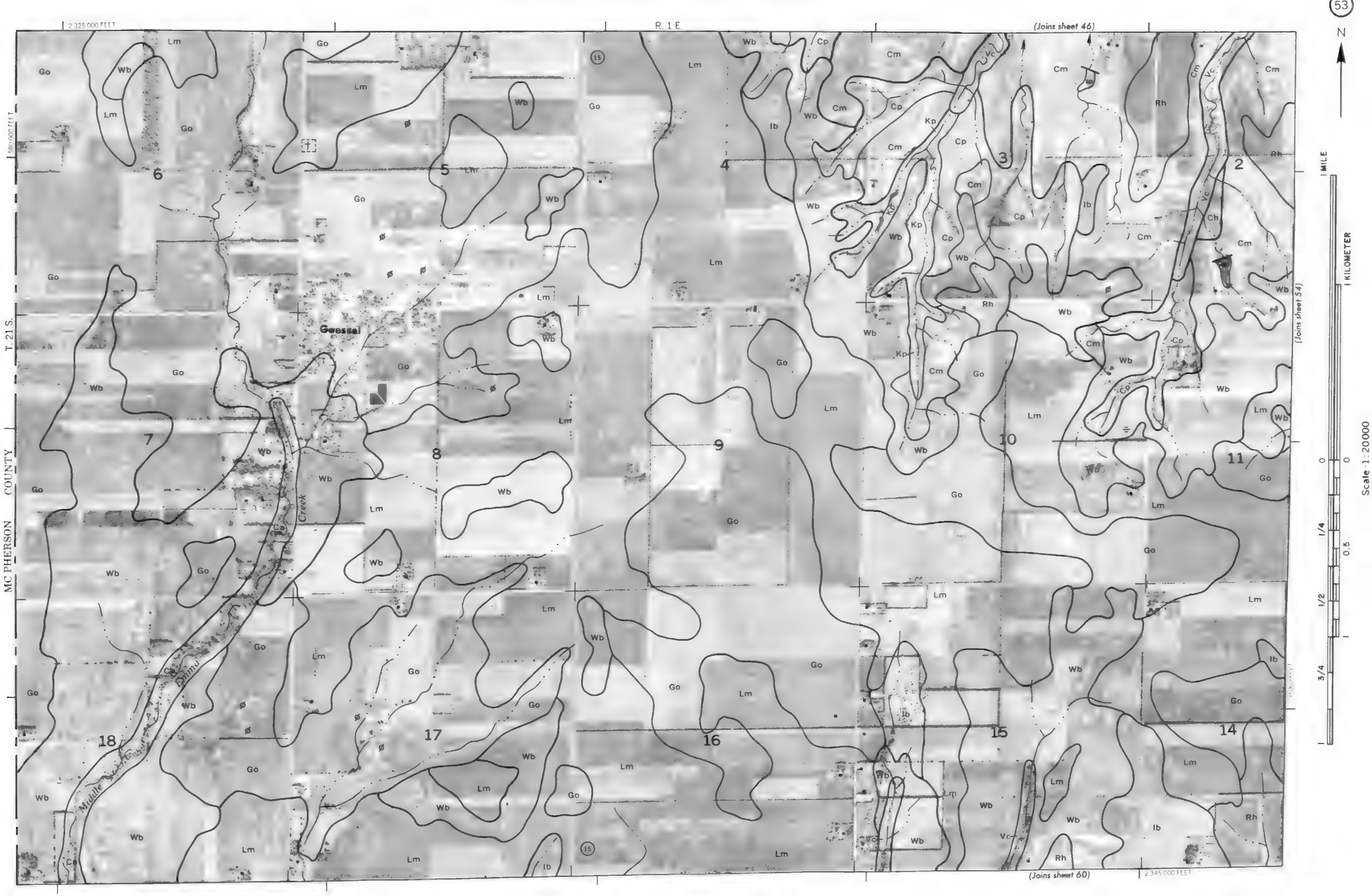

(Joins sheet 42)
R. 3 E.
2 400 000 FEET
595 000 FEET
T. 20 S.
(Joins sheet 50)
(Joins sheet 48)
(Joins sheet 56)
(57)
2 415 000 FEET
585 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
Spring Branch
Spring Branch Church
Catlin Creek
RAILROAD
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

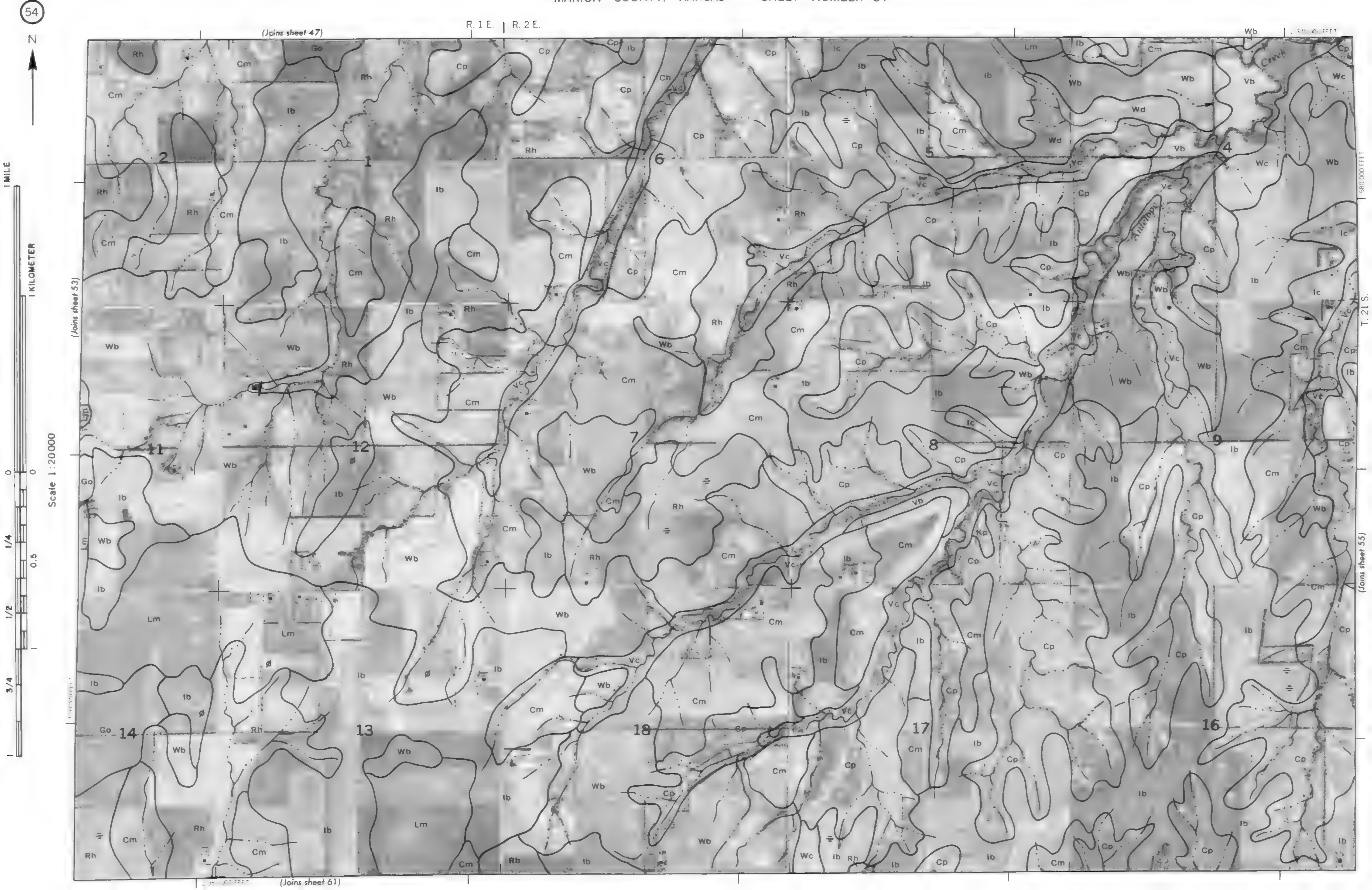

50
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 43)
R. 4 E.
2 440 000 FEET
(Joins sheet 49)
595 000 FEET
T. 20 S.
(Joins sheet 51)
585 000 FEET
2 420 000 FEET
(Joins sheet 57)
(Joins 58)
Cottonwood
River
Catlin
Creek
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35

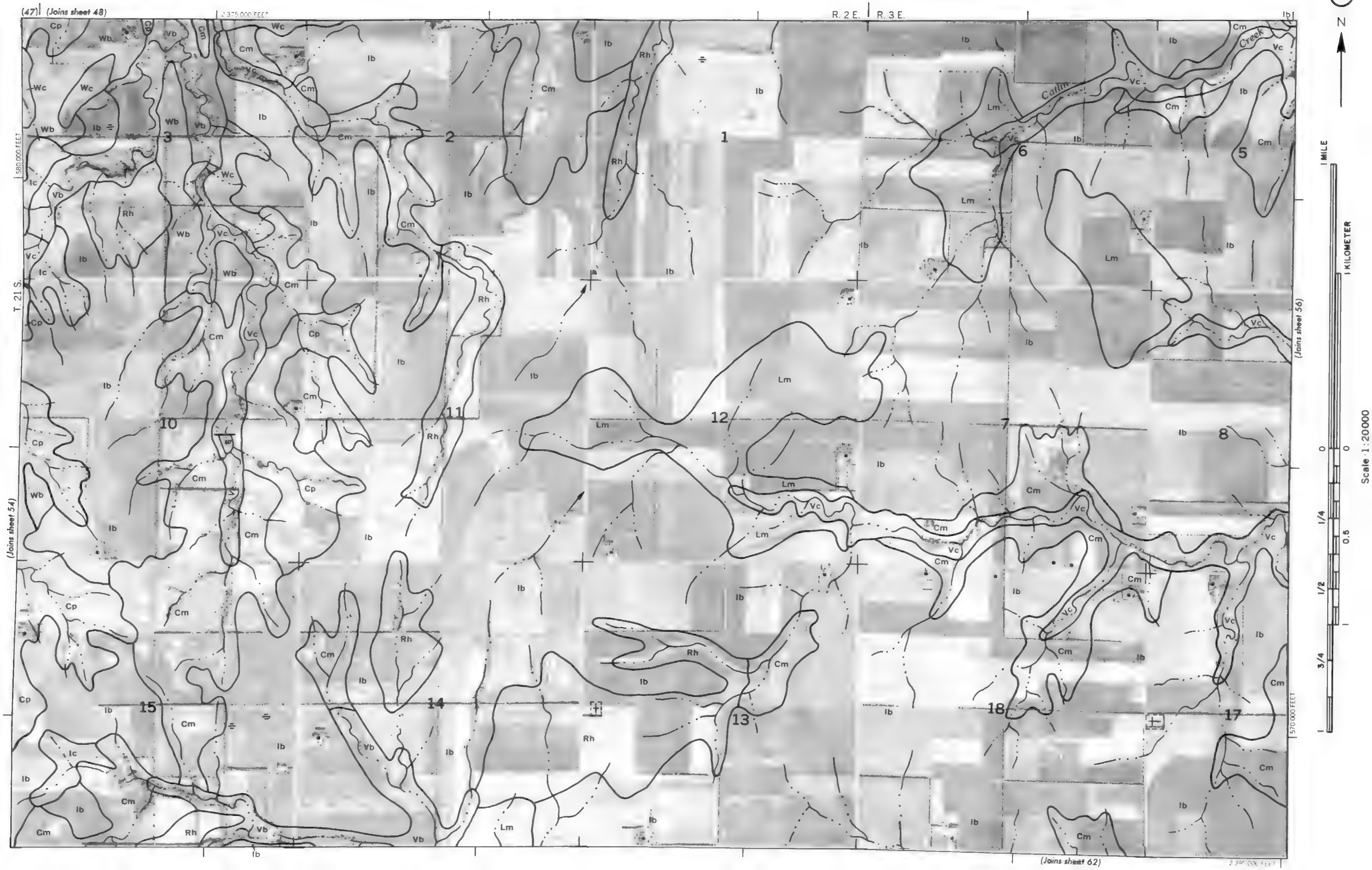

R. 4 E.
R. 5 E.
2 445 000 FEET
(Joins sheet 44)
(Joins sheet 52)
(Joins sheet 50)
(Joins sheet 58)
(Joins 59)
2 465 000 FEET
T. 20 S.
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
Martin Creek
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36


52
N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 45)
R. 5 E.
(Joins sheet 51)
T. 20 S.
CHASE COUNTY
(Joins sheet 59)
CHASE CO
Bruno Creek
Creek

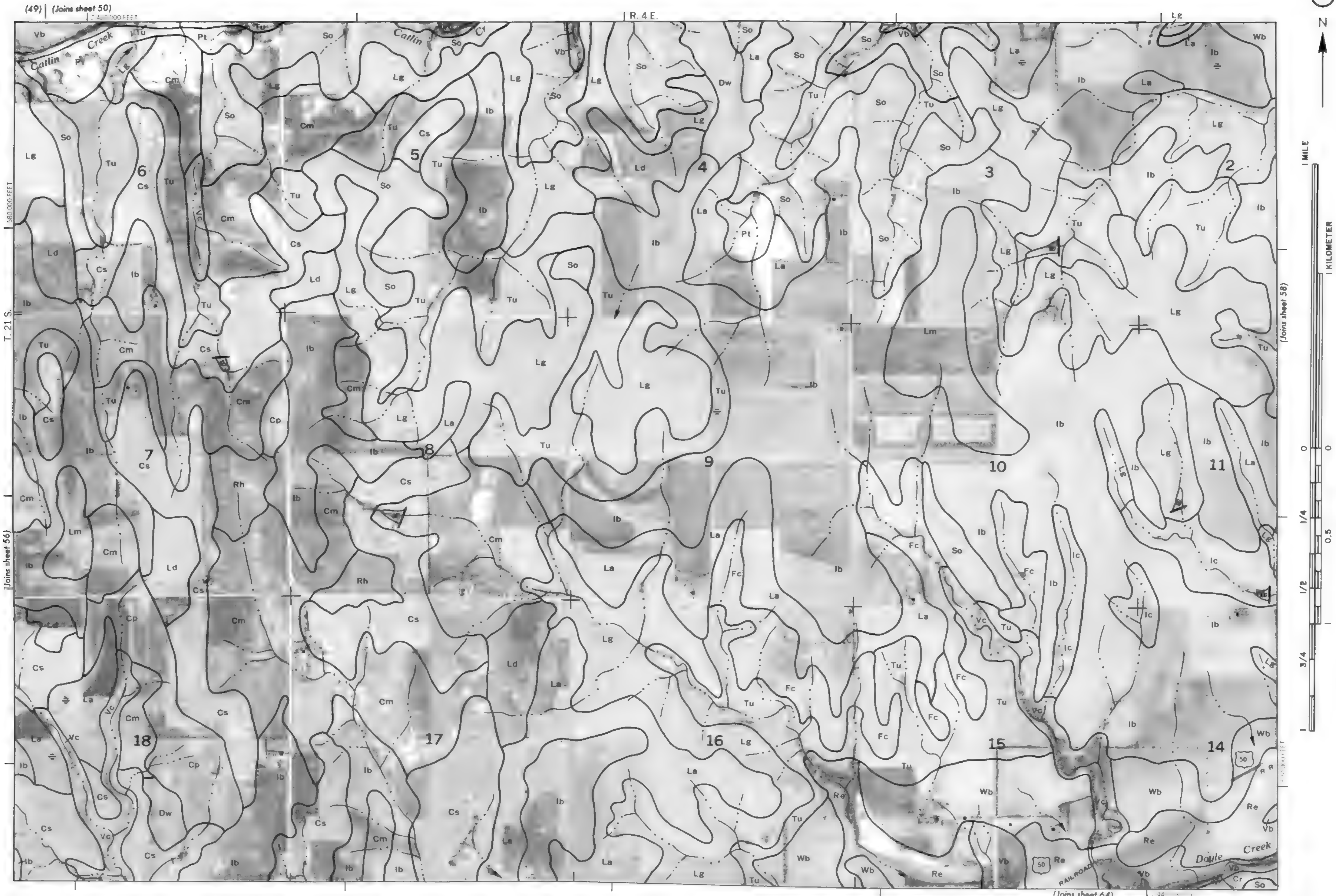

(Joins inset, sheet 45)
R. 4 E.
(Joins sheet 10)
T. 17 S.
MORRIS COUNTY
Clear Creek
Centre High School
(Joins sheet 16)

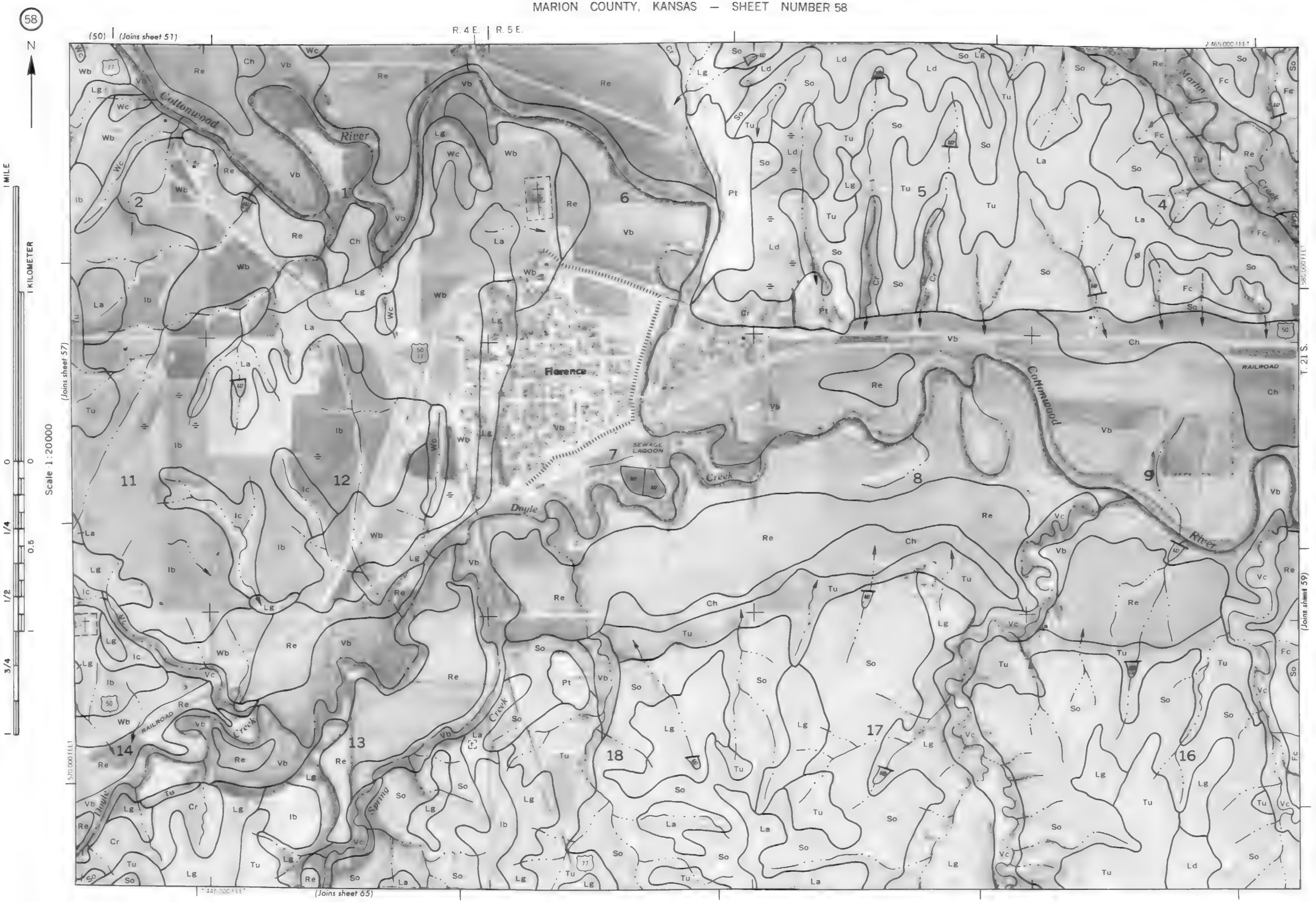

53
N
R. 1 E.
T. 21 S.
MC PHERSON COUNTY
(Joins sheet 46)
(Joins sheet 54)
(Joins sheet 60)
2 325 000 FEET
580 000 FEET
2 345 000 FEET
Goessel
Middle Emma Creek
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

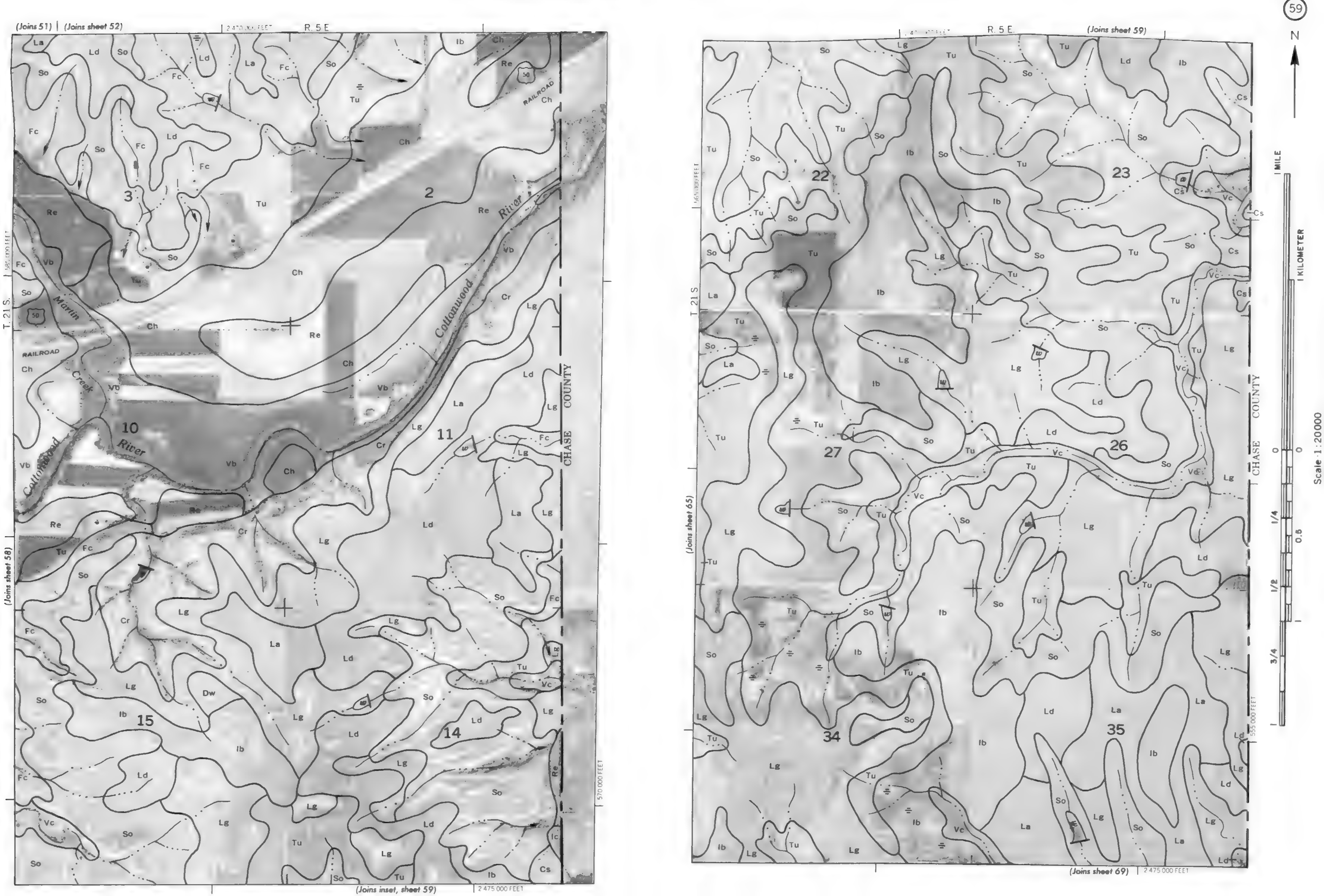

54
N
(Joins sheet 47)
R. 1 E.
R. 2 E.
(Joins sheet 53)
(Joins sheet 55)
(Joins sheet 61)
T. 21 S.
580 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
Creek
Antelope
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18

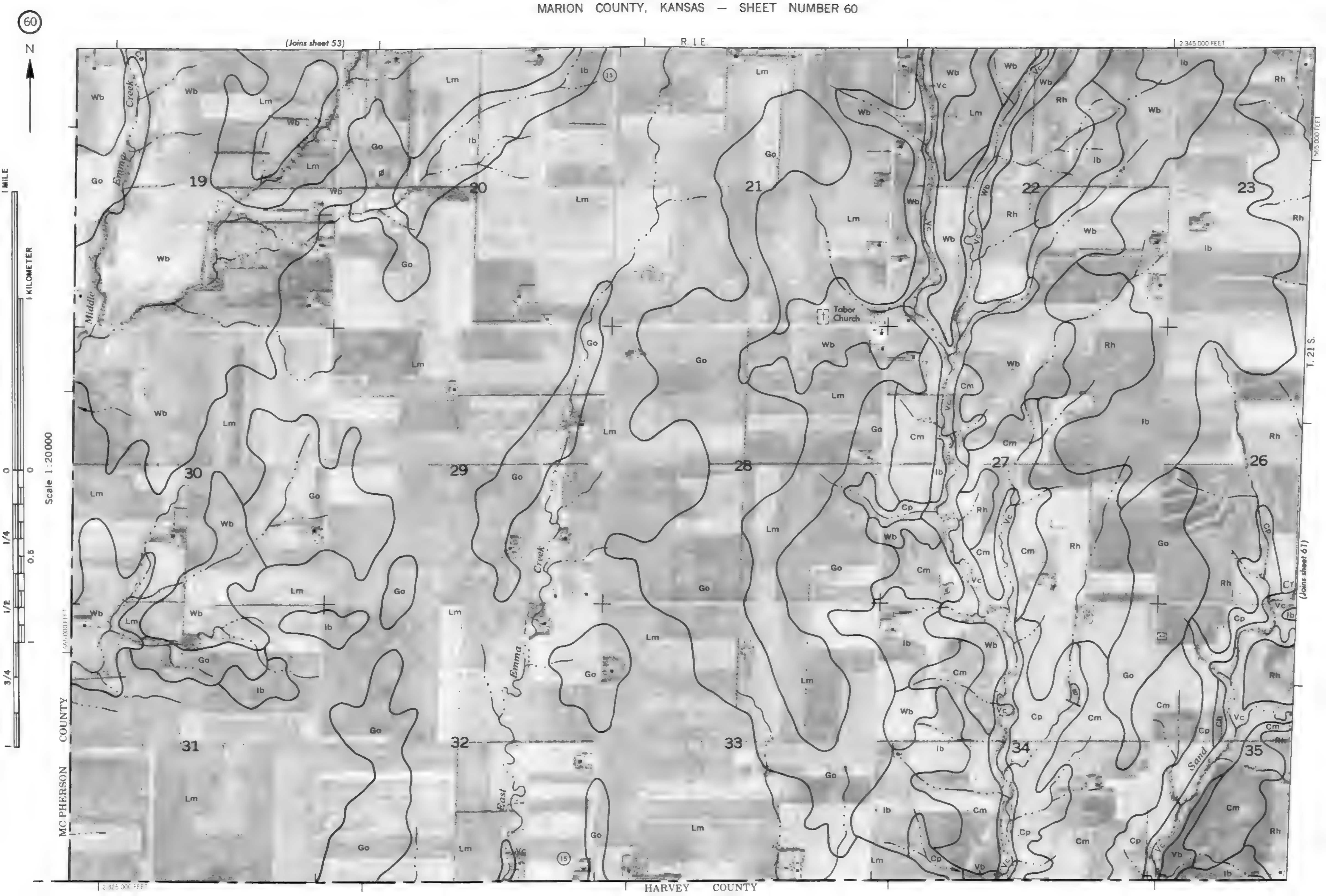

55
(47)
(Joins sheet 48)
2 375 000 FEET
R. 2 E.
R. 3 E.
580 000 FEET
T. 21 S.
(Joins sheet 54)
(Joins sheet 56)
(Joins sheet 62)
570 000 FEET
Catlin Creek
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18
Ib
Cm
Cp
Wb
Wc
Vb
Vc
Rh
Ic
Lm


56
N
(48)
(Joins sheet 49)
R. 3 E.
T. 21 S.
(Joins sheet 55)
(Joins sheet 57)
(Joins sheet 63)
2 400 000 FEET
570 000 FEET
Scale 1:20000
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Catlin Creek
Catlin Creek
RAILROAD
RAILROAD
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17
Ib
Cm
Vc
Ch
Rh
Re
Wb
Vb
La
Lg
Ld
Lm
Cs
Cp
So
Tu

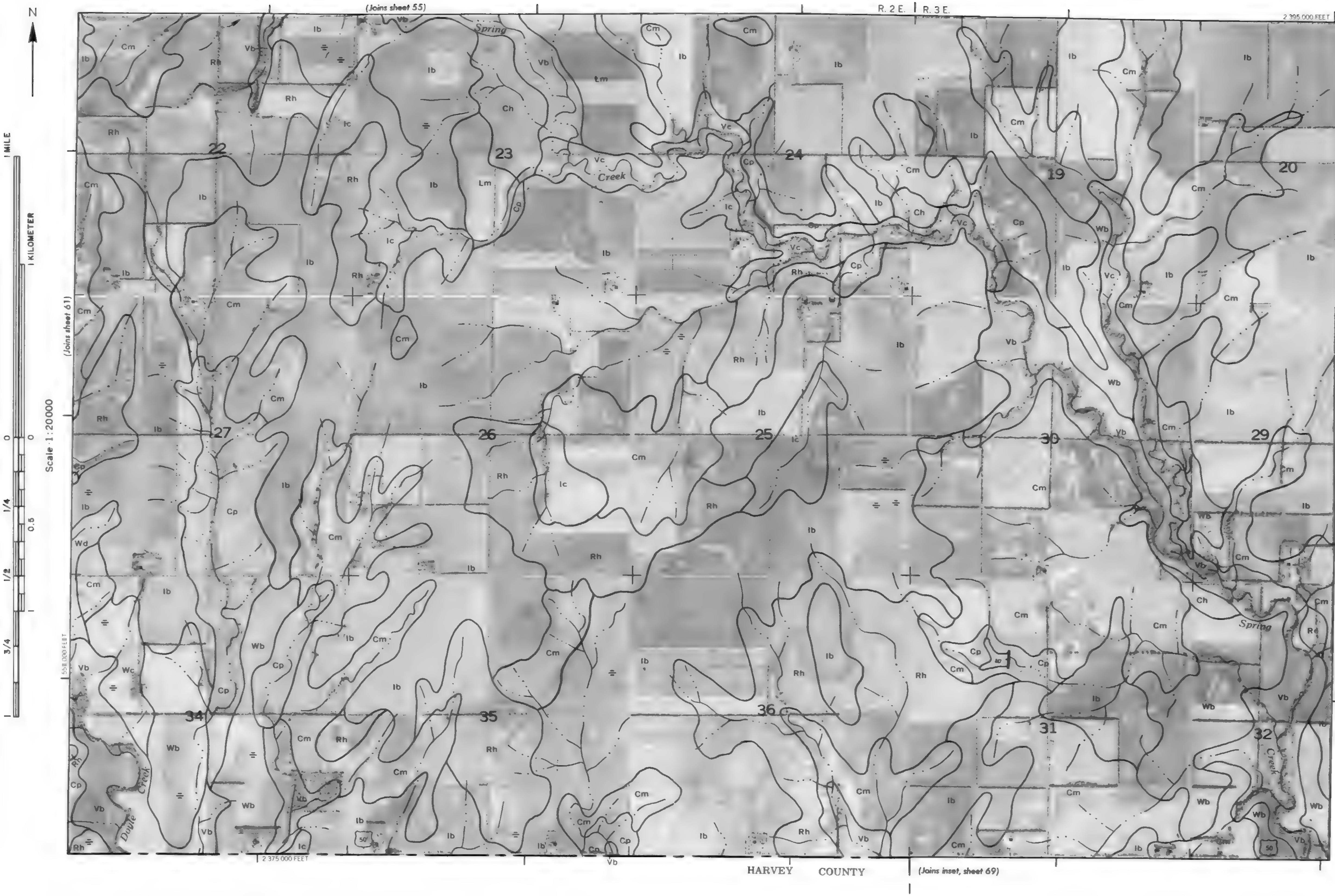

(49)
(Joins sheet 50)
2 440 000 FEET
R. 4 E.
T. 21 S.
580 000 FEET
(Joins sheet 56)
(Joins sheet 58)
(Joins sheet 64)
Catlin Creek
Doyle Creek
RAILROAD
50
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:20000
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18

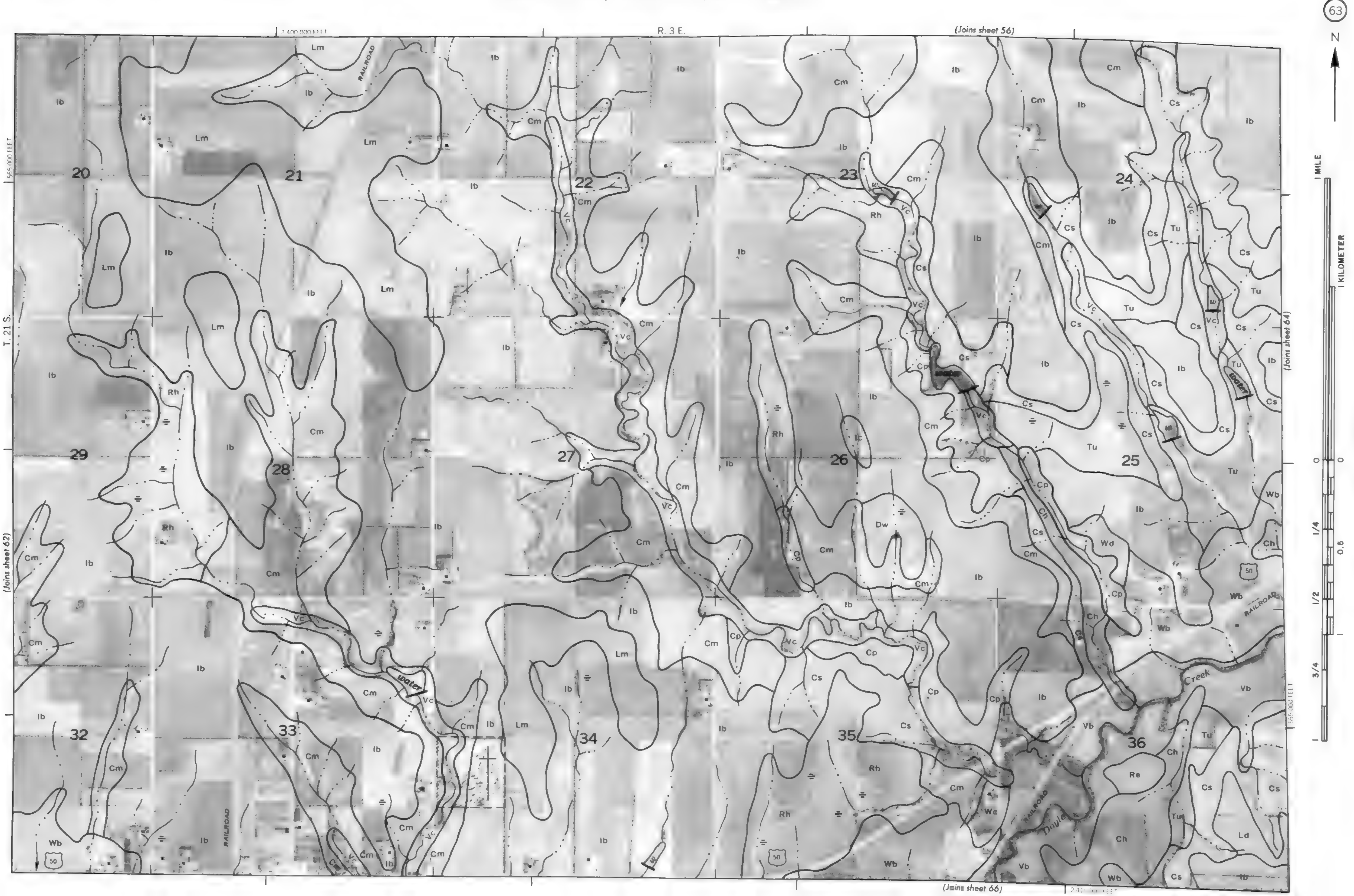

58
N
(50) (Joins sheet 51)
R. 4 E. R. 5 E.
(Joins sheet 57)
(Joins sheet 59)
(Joins sheet 65)
T. 21 S.
Scale 1:20000
1 MILE
1 KILOMETER
Cottonwood River
Florence
SEWAGE LAGOON
Doyle Creek
Martin Creek
Spring Creek
RAILROAD

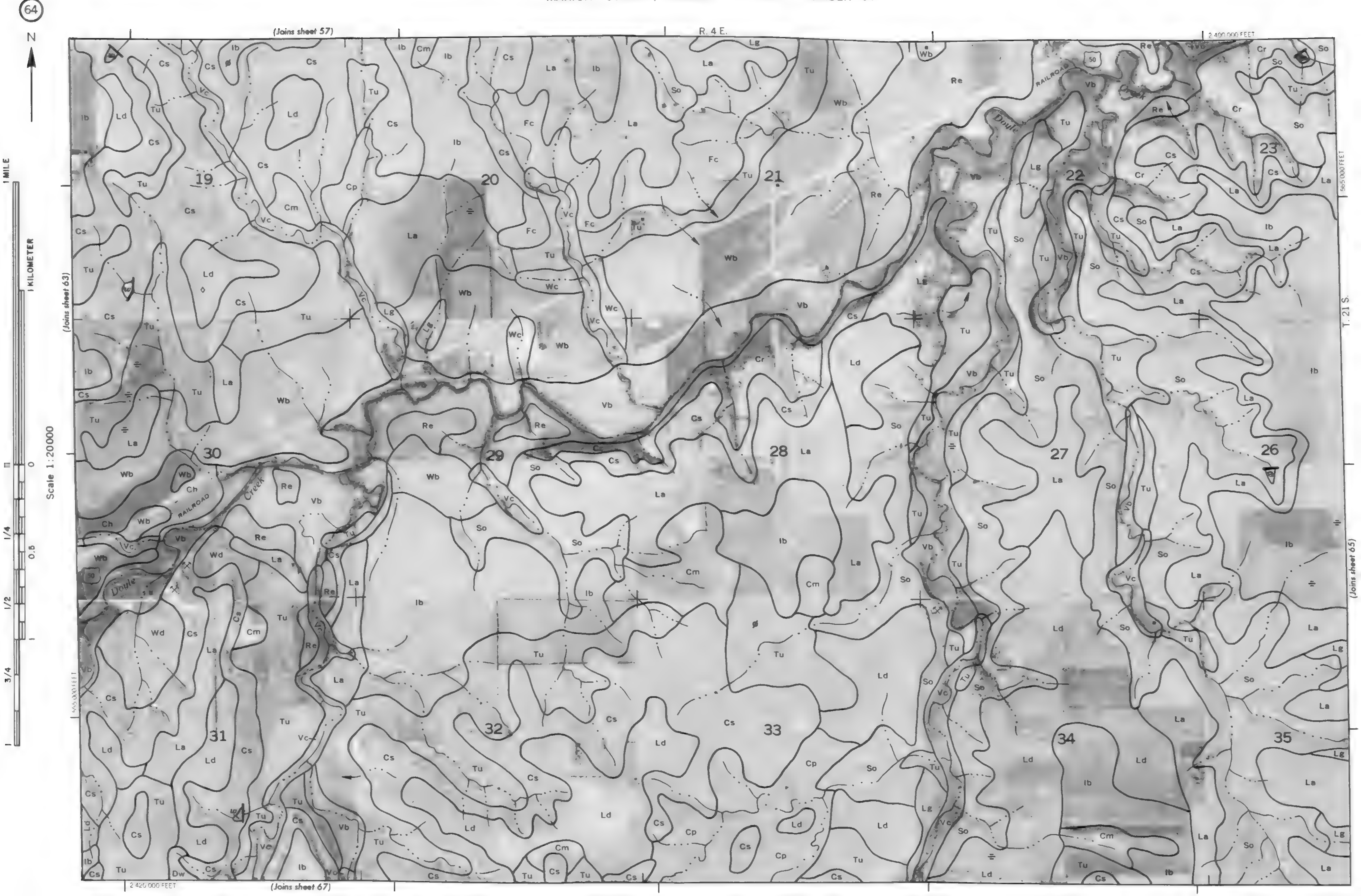

59
N
(Joins 51)
(Joins sheet 52)
R. 5 E.
T. 21 S.
(Joins sheet 58)
(Joins inset, sheet 59)
2 475 000 FEET
570 000 FEET
RAILROAD
50
Martin Creek
Cottonwood River
CHASE COUNTY
(Joins sheet 59)
(Joins sheet 65)
(Joins sheet 69)
555 000 FEET
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Scale 1:20000

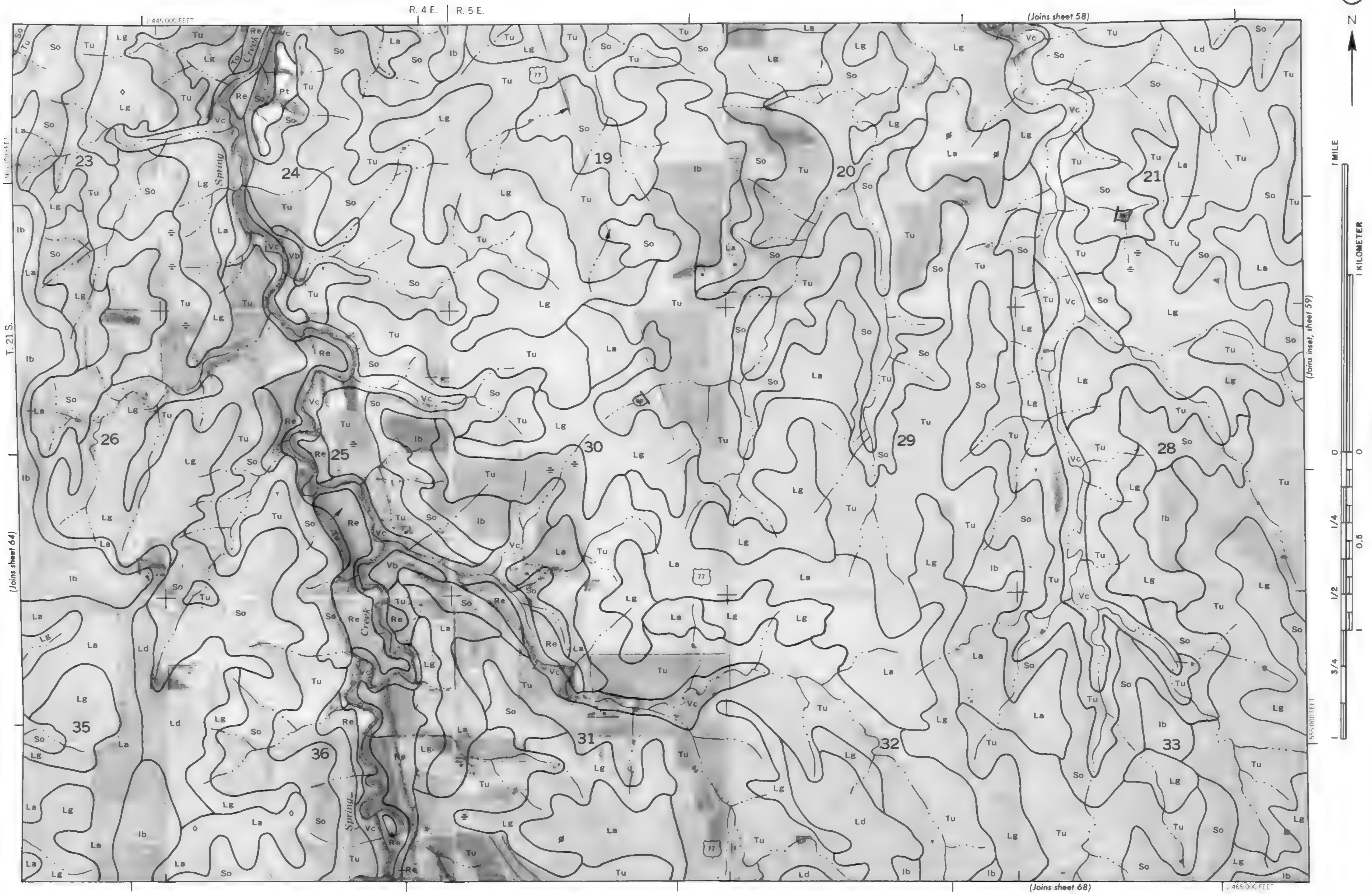

60
N
(Joins sheet 53)
R. 1 E.
2 345 000 FEET
565 000 FEET
T. 21 S.
(Joins sheet 61)
HARVEY COUNTY
MC PHERSON COUNTY
2 325 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
Middle Emma Creek
Emma Creek
East Emma
Sand
Tabor Church
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35


61
N
R. 1 E.
R. 2 E.
2 350 000 FEET
565 000 FEET
(Joins sheet 54)
(Joins sheet 62)
(Joins sheet 60)
T. 21 S.
Sand
Creek
HARVEY COUNTY
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0
0.5
Scale 1:20000
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36


N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
0.5
1/2
3/4
1
(Joins sheet 55)
R. 2 E.
R. 3 E.
2 395 000 FEET
565 000 FEET
T. 21 S.
(Joins sheet 61)
(Joins sheet 63)
558 000 FEET
2 375 000 FEET
HARVEY COUNTY
(Joins inset, sheet 69)
Spring Creek
Doyle Creek
Spring
Creek
50
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32


63
N
(Joins sheet 56)
R. 3 E.
2 400 000 FEET
T. 21 S.
565 000 FEET
(Joins sheet 62)
(Joins sheet 64)
(Joins sheet 66)
555 000 FEET
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
RAILROAD
Creek
Doyle
water
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

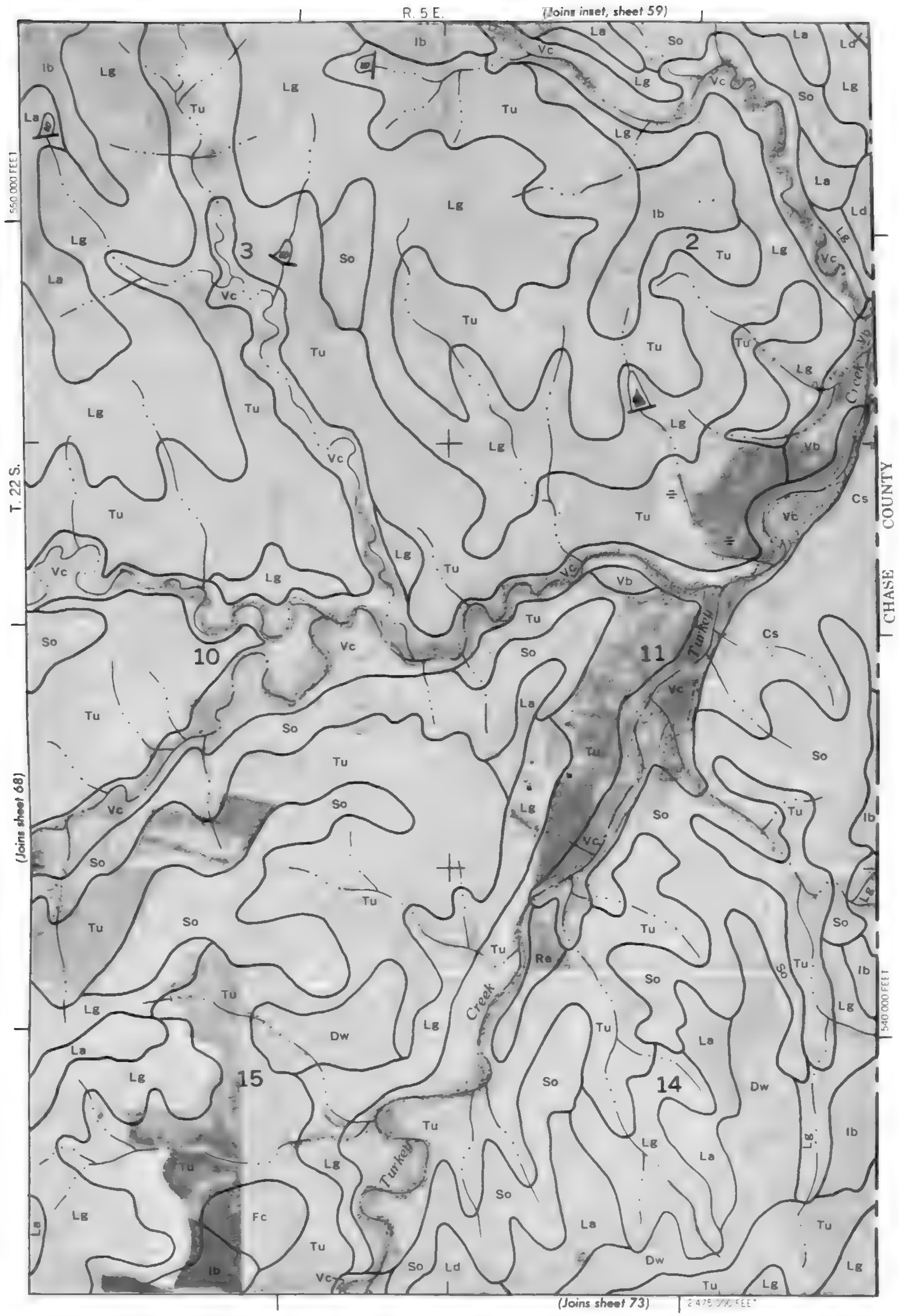

64
N
(Joins sheet 57)
R. 4 E.
2 400 000 FEET
565 000 FEET
T. 21 S.
(Joins sheet 65)
(Joins sheet 63)
(Joins sheet 67)
2 420 000 FEET
555 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
RAILROAD
Doyle Creek
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35

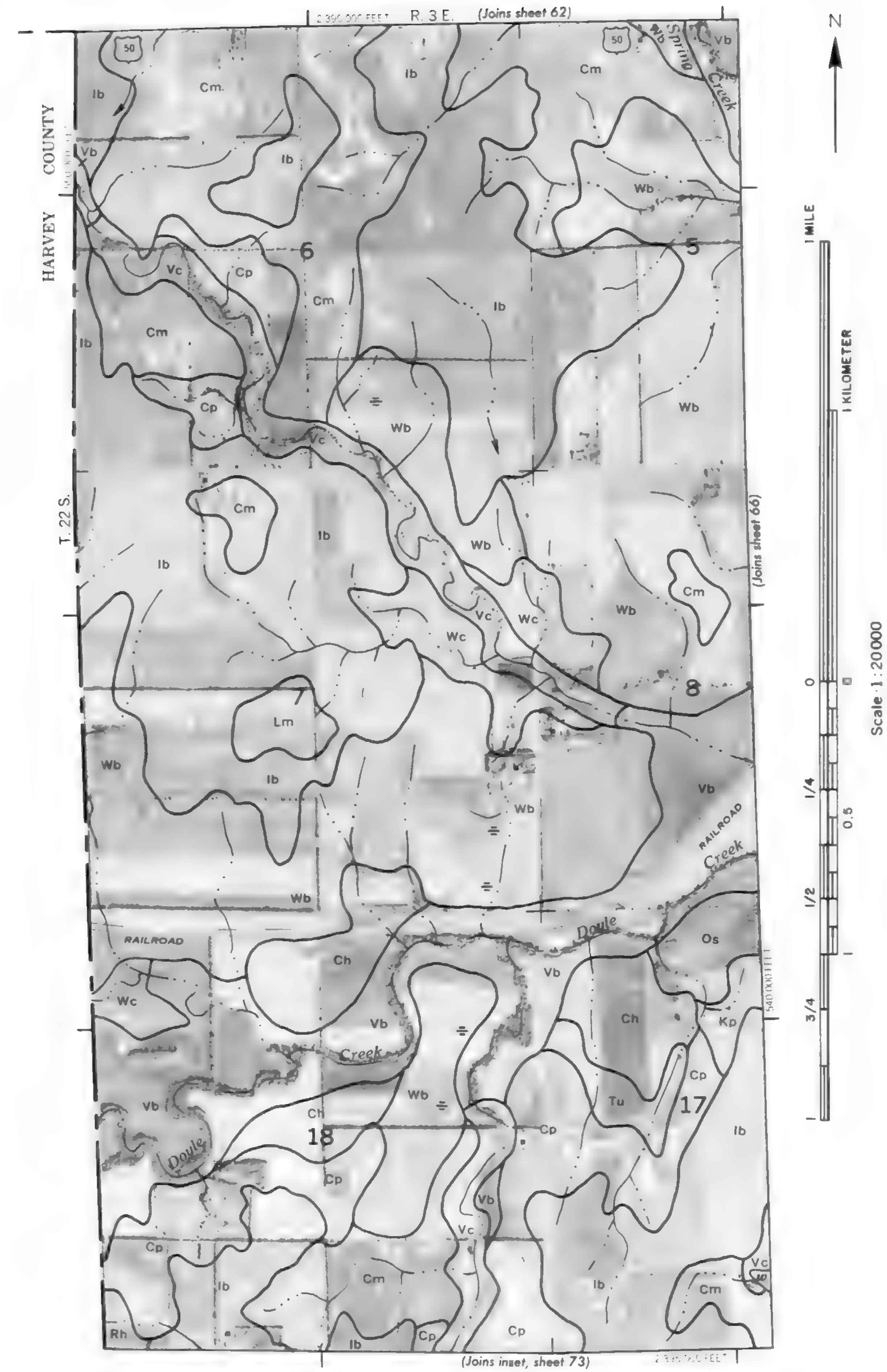

R. 4 E.
R. 5 E.
2 445 000 FEET
(Joins sheet 58)
(Joins inset, sheet 59)
(Joins sheet 64)
(Joins sheet 68)
2 465 000 FEET
555 000 FEET
T. 21 S.
Spring
Creek
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36


N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0
0.5
Scale 1:20000
(Joins sheet 63)
R. 3 E.
2 415 000 FEET
550 000 FEET
T. 22 S.
(Joins sheet 67)
(Joins inset, sheet 69)
540 000 FEET
(Joins sheet 70)
2 400 000 FEET
PEABODY
RAILROAD
Spring
Creek
Doyle
water
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17
Cm
Vb
Wb
Ib
Ic
Cp
Vc
Lm
Rh
Ch
Cs
Tu
Kp
La
Os


R. 4 E.
T. 22 S.
(Joins sheet 64)
(Joins sheet 68)
(Joins sheet 66)
(Joins sheet 71)
2 420 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
1
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18


N
(Joins sheet 65)
R. 4 E.
R. 5 E.
(Joins sheet 67)
(Joins sheet 69)
(Joins sheet 72)
T. 22 S.
Spring Creek
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1


R. 5 E.
(Joins inset, sheet 59)
550 000 FEET
T. 22 S.
(Joins sheet 68)
CHASE COUNTY
540 000 FEET
Turkey Creek
Creek
Turkey
2
3
10
11
14
15
(Joins sheet 73)
2 475 000 FEET

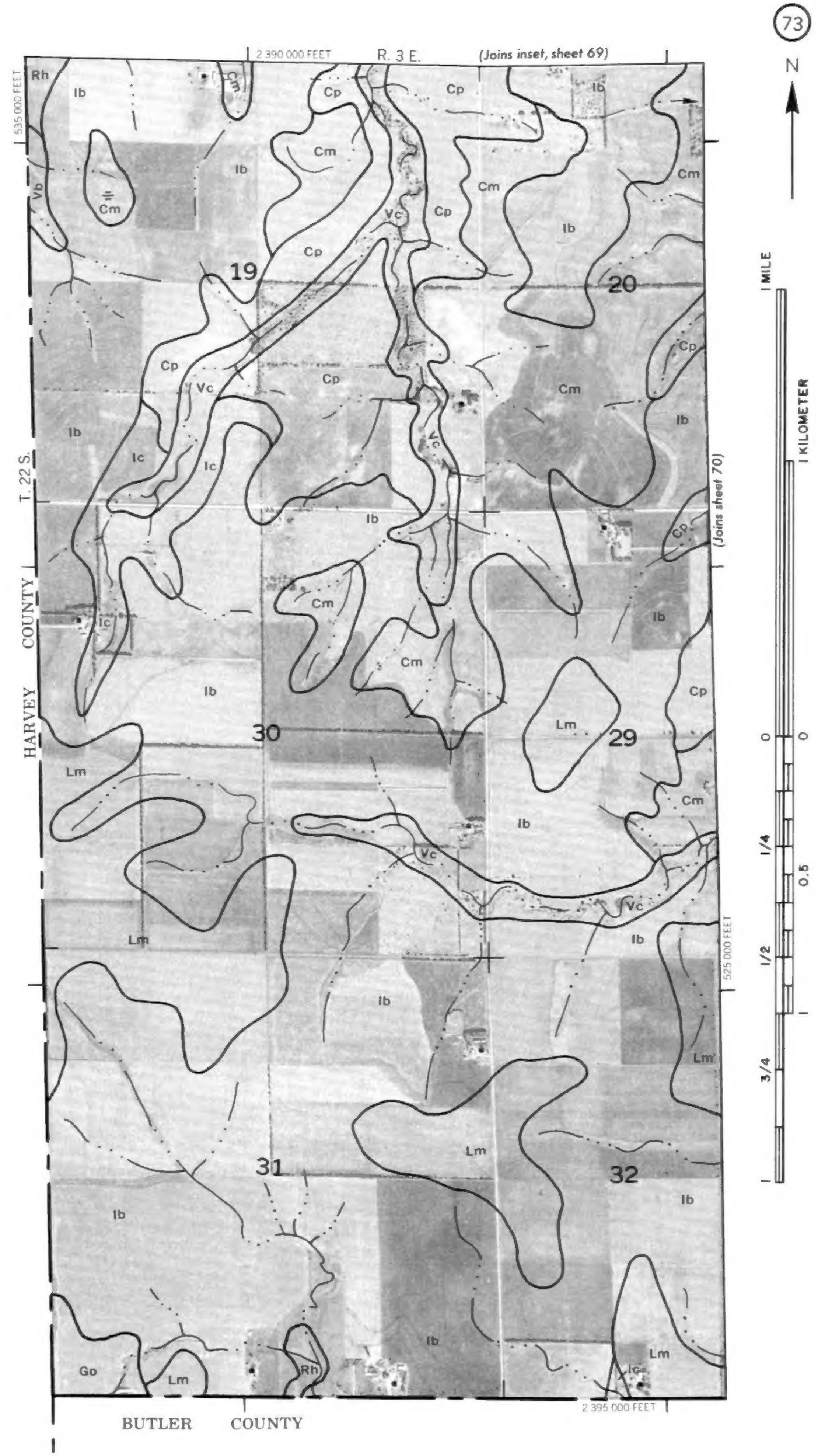

R. 3 E.
(Joins sheet 62)
50
Spring Creek
HARVEY COUNTY
T. 22 S.
(Joins sheet 66)
RAILROAD
Doyle Creek
Doyle
Creek
5
6
7
8
17
18
(Joins inset, sheet 73)
N
1 MILE
1 KILOMETER
0
1/4
0.5
1/2
3/4
Scale 1:20 000


(Joins sheet 66)
R. 3 E.
2 415 000 FEET
535 000 FEET
T. 22 S.
(Joins sheet 71)
(Joins inset, sheet 73)
525 000 FEET
2 400 000 FEET
BUTLER COUNTY
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
RAILROAD
water
20
21
22
23
24
29
28
27
26
25
32
33
34
35
36
Ib
Ic
Cm
Cp
Vc
Lm
Rh
Wb


71
N
2 420 000 FEET
535 000 FEET
R. 4 E.
(Joins sheet 67)
(Joins sheet 72)
(Joins sheet 70)
T. 22 S.
Summit Church
Whitewater Center Church
Whitewater River
BUTLER COUNTY
525 000 FEET
2 440 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
water


N
(Joins sheet 68)
R. 4 E.
R. 5 E.
2 465 000 FEET
535 000 FEET
T. 22 S.
(Joins sheet 71)
(Joins sheet 73)
525 000 FEET
2 445 000 FEET
BUTLER COUNTY
1 MILE
1 KILOMETER
Scale 1:20000
Burns
First Church
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36


2 470 000 FEET
R. 5 E.
(Joins sheet 69)
535 000 FEET
T. 22 S.
Turkey
Creek
22
23
27
26
34
35
(Joins sheet 72)
525 000 FEET
CHASE COUNTY
BUTLER COUNTY
2 475 000 FEET


73
2 390 000 FEET
R. 3 E.
(Joins inset, sheet 69)
535 000 FEET
N
T. 22 S.
HARVEY COUNTY
19
20
30
29
31
32
(Joins sheet 70)
525 000 FEET
BUTLER COUNTY
2 395 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000